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PHYSIQUE AND INTELLECT

THE CENTURY PSYCHOLOGY SERIES

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*HISTORY OF EXPERIMENTAL PSYCHOLOGY, by Edwin G. Boring; *GREAT EXPERIMENTS IN PSYCHOLOGY, by Henry E. Garrett; *PHYSIQUE AND INTELLECT, by Donald G. Paterson; SOCIAL PSYCHOLOGY, by Charles Bird; PURPOSIVE BEHAVIOR, by Edward C. Tolman; METHODS OF STUDYING THE YOUNG CHILD, by Florence L. Goodenough and John E. Anderson; SYSTEMS IN PSYCHOLOGY, by Edna Heidbreder; HOW TO STUDY, by Charles Bird; BEAUTY AND HUMAN NATURE, by Albert R. Chandler; HUMAN MOTIVES AND INCENTIVES, by H. A. Toops; SUGGESTION AND HYPNOSIS, by Clark L. Hull; CHILD PSYCHOLOGY, by John E. Anderson; MENTAL AND PHYSICAL TRAINING AND THEIR RELATION, by Donald G. Paterson.

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PHYSIQUE AND INTELLECT

BY DONALD G. PATERSON
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UNIVERSITY OF MINNESOTA

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PREFACE

In 1928 the writer was invited to participate in a symposium on the Measurement of Mankind sponsored by the University of Minnesota Chapter of Sigma XI. Four public lectures were delivered and later published in book form: "The Measurement of Man in the Mass," by the late Dr. J. Arthur Harris; "The Measurement of Physical Growth," by Dr. Richard E. Scammon; "Physical Development and Types," by Dr. Clarence M. Jackson; and "Mental Development in Relaton to Physical Development and Types," by the writer.[1] Within the limits of a single lecture each of these problems could be barely more than outlined.

While preparation of the lecture assigned to me was in progress I noted the keen interest of students enrolled in a course on The Psychology of Individual Differences in reviewing and evaluating published research reports bearing on different phases of the problem of physical and mental traits. Undergraduate and graduate students alike were puzzled by conflicting conclusions in the literature and were eager to get systematically at the root of the available evidence in order to clarify their own ideas. This enthusiasm prompted me to undertake for them a critical synthesis of the available literature, one which would enable the student to orient himself without consulting a relatively large number of scattered references.

The topic falls strictly within the field of the Psychology of Individual Differences, where textbooks are surprisingly few in number. In fact, since Thorndike outlined the subject as part of his three-volume work on Educational Psychology in 1914 only one text devoted exclusively to individual differences has appeared.[2] At first sight, this may seen a strange state of affairs, since differential psychology has enjoyed a more vigorous growth during the past fifteen or twenty years than any other branch of the science. Does the explanation lie in the fact that material, both theoretical and applied, has accumulated at such an unprecedented rate that the task of systematic presentation has become almost impossible? To-day an adequate summary of all now comprised in the psychology of individual differences would necessitate not one volume but many. Even a limited phase of the field requires a book as extensive as the present one. The task of comprehensive synthesis will be facilitated if other aspects of the problem can be systematized in a similar manner.

---

[1] J. Arthur Harris, R. E. Scammon, C. M. Jackson, and D. G. Paterson, *The Measurement of Man* (The University of Minnesota Press, Minneapolis, 1930).

However much any writer might shrink from the task of presenting *in toto* the field of individual psychological differences, he could with less misgiving and more propriety attempt a brief résumé of a limited portion of the field. Even so, the writer of the present study is anxious at the outset to apologize for its numerous shortcomings. Merely to list the names of the several scientific disciplines dealt with or drawn upon in its pages is to win a hearing from all fair-minded critics for the writer's earnest plea for indulgence. These disciplines include: Physics, Roentgenology, Chemistry, Anatomy, Craniology, Phrenology, Physiognomy, Physiology, Dentistry, Medicine, Pediatrics, Neurology, Psychiatry, Endocrinology, Paleontology, Anthropology, Psychology, Sociology, Metaphysics, Logic, Statistics and Biometry, Psychometry, and Anthropometry. Recourse to these varied fields of knowledge was imposed by the borderland nature of the problems discussed rather than by any compulsive desire on the part of the writer to stray from the confines of his own specialty. One compensation remains to counterbalance the risk of adverse judgment from divers specialists, namely, the possibility that the book will come to the attention not only of students of psychology but also of public health workers, psychiatrists, pediatricians, anatomists, anthropologists, sociologists, educators, and others concerned with child development, care, training, or guidance.

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[2] R. S. Ellis, *The Psychology of Individual Differences*, (D. Appleton and Company, New York, 1928).

To acknowledge indebtedness for aid in preparing a manuscript is not only an opportunity for expressing appreciation but also an obligation of serious moment. In a real sense, my chief indebtedness is to my former teacher, Dr. Rudolf Pintner, who taught me that problem solving in psychology is more profitably undertaken through the technical media of quantitative research than through the processes and refinements of verbalization. He has continually encouraged my research efforts and more recently has rendered important bibliographical aid. But my heaviest immediate obligation is to Dr. Richard M. Elliott, editor of the Century Psychology Series,—friend and colleague. Throughout the past two years he constantly encouraged me, and in the final stages of manuscript preparation devoted himself unstintingly to the task of editorial revision. Few writers have been privileged to receive such generous and competent aid. A good part of whatever stylistic merit inheres in the writing is due to his editorial skill.

My colleagues, Dr. Charles Bird and Dr. Miles A. Tinker, read the manuscript in its entirety and offered many specific and helpful criticisms and suggestions. Dr. Florence Goodenough of the Institute of Child Welfare of the University of Minnesota also gave bibliographic assistance, and in the course of numerous discussions of these problems aided in clarifying some of the controversial issues. Unusually intelligent and accurate typing and stenographic service was afforded by Miss Nancy Johnson and Miss Lillian Hasselmeyer. Numerous individuals on the staff of the University of Minnesota Library went beyond what could reasonably be expected of them in their zeal to track down elusive books, periodicals, and research bulletins.

The University of Minnesota Press kindly permitted the use of certain figures included in my lecture in "The Measurement of Man." The officers of the Press, Dean Guy Stanton Ford and Mrs. Margaret S. Harding, also were most generous in acquiescing to the proposal to expand the original lecture material into book form for independent publication. It is obvious that such an expansion necessarily involved some repetition of a character which would have made specific citations cumbersome. Grateful appreciation is also due other publishers and writers who granted permission to reproduce cuts and diagrams and to quote liberally from their books and research publications. Specific references cited in the text indicate all these favors.

The very nature of the present undertaking necessitated a direct obligation to all who have contributed during the past forty years to our knowledge of the relation between physical and mental traits. If in criticism of some of these contributors the tone seems somewhat severe, it should be borne in mind that my purpose was primarily pedagogical and that pedagogy requires emphasis. We frequently learn as much through the mistakes of others as we do through the study of perfect methodology and interpretation. After all, progress in any field of knowledge is in some measure dependent upon processes of "trial and error."

Donald G. Paterson

The University of Minnesota
June 12, 1930.

EDITOR'S INTRODUCTION

The most effective introduction to Professor Paterson's book would be a page divided down the middle, the left hand column listing the most commonly accepted views of the relation between mental traits and their bodily accompaniments and the right hand column listing the conclusions set forth in the present volume. By this device a striking disparity between science and layman's lore would be disclosed. The column containing superstitions sometimes fantastic, errors elaborately buttressed, prejudices so ingrained as to seem "self-evident," would be endlessly long. The human mind is insatiably eager to detect *positive* connections between events and phenomena within and even beyond the range of its observation.

On the other hand, the sobering and disillusioning activity of counting *negative* instances, by which we detect the failure of a law to apply universally or what is the same thing, the falsity of the law, is reluctantly indulged in by laymen and even by accredited scientists. Even when correctly practiced it fails to hold for long the attention of any except the stoutest and most quantitatively minded skeptics, for its use discloses tangles of relationships among data for which only intricate statistical techniques are adequate instruments of analysis. Here the layman certainly falters and even the educator, physician or psychologist, in the desperation born of practical need, may revert to the comforting and supporting affirmation of positive connections. In that case, since he is unintentionally a victim of the oldest fallacy in human thought, he follows the traditions of the medicine man. His beliefs and procedures occupy a position in the vast twilight zone of science. His greatest need is for a searchlight. That is exactly what the present book is.

The work of Professor Paterson in the field of mental measurement is so favorably known among his colleagues that it would need no special notice here except for the undoubted appeal of the present volume to many readers who are not oriented specifically in psychology. Among his contributions related to the present undertaking are his part in the standardization of the Pintner-Paterson Performance Tests, his service as psychological examiner for the Ohio Bureau of Juvenile Research at the time it was first organized, and as Chief Psychological Examiner in the United States Army in 1917-1919. His connection with the University of Minnesota since 1921 has been marked by frequent and diversified contributions to psychological journals. In closest relation to the present volume are those which deal with the psychology of deafness, the rating of human traits, and the measurement of mechanical ability.

Professor Paterson's *Physique and Intellect* is the first comprehensive synthesis of a field where no evidence worthy of being called scientific could exist prior to a time when psychometrics reached, if not maturity, at least a stage of accountable and sophisticated development. Students of a dozen different fields will be surprised that so important a survey has not been undertaken before and will be grateful for the resoluteness, workmanlike sobriety, and penetrating clarity with which it is now accomplished. That it is so largely an exposé, carried through with devastating thoroughness, testifies with added force to its timeliness and value as a text in courses in differential psychology. It has a place in every course in psychology where the nature and origin of differences in mental makeup are touched upon. Moreover, since the problems discussed in it cross the traditional dividing boundaries of the sciences it should have a wide reading among physicians, psychiatrists, supervisors and teachers of special classes, pediatricians, social and public health workers, and many others.

R. M. E.

CONTENTS

CHAPTER PAGE

I PRELIMINARY CONSIDERATIONS 3

- 1 INTRODUCTION 3
- 2 THE NECESSITY FOR ACCURATE MEASUREMENTS AND ADEQUATE STATISTICAL METHODS . . 6
- 3 THE NECESSITY OF WITHSTANDING THE TEMPTATION TO CLASSIFY MANKIND INTO "TYPES" 9
- 4 MEASURES OF PHYSICAL TRAITS 13
- 5 MEASURES OF INTELLIGENCE 14
- 6 THE SIGNIFICANCE OF INDIVIDUAL DIFFERENCES IN MENTAL AND PHYSICAL TRAITS . . . 20

II HEIGHT AND WEIGHT IN RELATION TO INTELLECT 24

- 1 HISTORICAL REASONS FOR BELIEF IN CLOSE CORRELATION BETWEEN PHYSICAL STATUS AND INTELLECT 24
- 2 STUDIES OF CHILDREN 30
  - a CHILDREN OF AVERAGE INTELLIGENCE . . 30
  - b FEEBLE-MINDED AND MENTALLY DULL CHILDREN 52
  - c GIFTED OR PRECOCIOUS CHILDREN . . . 66
- 3 STUDIES OF ADULTS 69
- 4 THE POSSIBLE INFLUENCE OF SOCIAL STATUS . 71
- 5 SIGNIFICANCE OF THE FINDINGS 75

CHAPTER PAGE

III CRANIAL MEASUREMENTS AND INTELLIGENCE . 80
- 1 BRIEF HISTORICAL INTRODUCTION 80
- 2 QUANTITATIVE STUDIES ON HEAD SIZE . . . 84
- 3 THE RESEARCHES OF S. D. PORTEUS 102
- 4 ADDITIONAL STUDIES ON HEAD SIZE 112
- 5 STUDIES OF HEAD SHAPE 116
- 6 SUMMARY 122

IV ANATOMICAL AGE AND MENTAL AGE 124
- 1 THE CONCEPTS OF ANATOMICAL AGE AND PHYSIOLOGICAL AGE 124
- 2 MEASURING SKELETAL DEVELOPMENT . . . 125
- 3 RESEARCH STUDIES ON THE RELATION BETWEEN ANATOMICAL AGE AND MENTAL AGE . . . 127
- 4 PUBESCENCE AS AN INDEX OF PHYSIOLOGICAL DEVELOPMENT 138
- 5 DENTITION AS AN INDEX OF ANATOMICAL AGE . 147
- 6 SUMMARY 156

V MORPHOLOGICAL INDEX, HEIGHT-WEIGHT RATIO, AND INTELLIGENCE 160
- 1 THE MORPHOLOGICAL THEORIES OF S. NACCARATI 160
- 2 ATTEMPTS TO VERIFY NACCARATI'S THEORIES . 164
- 3 ADDITIONAL EVIDENCE ON BODY BUILD AND INTELLIGENCE 168
- 4 SUMMARY 169

CHAPTER PAGE

VI Physical Condition and Mental Efficiency 170

1 THE MENTAL EFFECTS OF MALNUTRITION . . 172

2 THE INFLUENCE OF PHYSICAL DEFECTS . . . 176

3 ADENOIDS AND DISEASED TONSILS 182

4 GLANDULAR DYSFUNCTION 187

5 HOOKWORM 194

6 INTESTINAL TOXEMIA 197

7 DENTAL CARIES AND IMPACTED TEETH . . . 199

8 OTHER PHYSICAL CONDITIONS 204

9 ENCEPHALITIS LETHARGICA 207

10 SUMMARY 211

VII Physique and Temperament 213

1 PHYSIOGNOMIC TRAITS IN RELATION TO TEMPERAMENT 214

2 MORPHOLOGIC TYPES IN RELATION TO PERSONALITY TRAITS 220

3 BODY BUILD AND PHYSICAL DEFECTS IN RELATION TO ADLER'S CONCEPT OF "ORGAN INFERIORITY" 227

4 PHYSICAL CONSTITUTION AND PSYCHOTIC TEMPERAMENT 231

5 BIOCHEMICAL APPROACHES TO PERSONALITY . 248

6 PSYCHOLOGICAL AND ANTHROPOMETRIC MEASURES OF MASCULINITY 255

7 SUMMARY 266

CHAPTER PAGE
VIII SUMMARY AND CONCLUSIONS 269
1 TREND OF THE EVIDENCE 269
2 BEARING OF THE ASSEMBLED EVIDENCE ON CURRENT VIEWS 270
3 THEORY OF UNIQUE TRAITS 276
4 PRESENT STATUS OF THE PROBLEM 277
5 SUGGESTED LINES FOR FURTHER RESEARCH . . 280
6 LIMITATIONS OF PREVIOUS RESEARCH STUDIES . 284
7 BEARING OF THE EVIDENCE ON THE PROBLEM OF INDIVIDUAL DIFFERENCES IN INTELLECT . . 288
INDEX OF NAMES 291
INDEX OF SUBJECTS 295

ILLUSTRATIONS

FACING PAGE

PHOTOGRAPH OF A GROUP OF DWARFS AND MIDGETS EXHIBITED AT LUNA PARK, CONEY ISLAND, 1915 . . 26

FRONT VIEW OF LOW-GRADE MICROCEPHALIC IMBECILE, CHRONOLOGICAL AGE 25, MENTAL AGE 3 82

PROFILE VIEW OF SAME MICROCEPHALIC IMBECILE . . 82

CONTRASTING PATHOLOGICAL TYPES OF IMBECILITY; HYDROCEPHALY ON THE LEFT, MICROCEPHALY ON THE RIGHT 106

X-RAY PICTURES SHOWING THREE OF THE THIRTEEN STAGES OF ANATOMICAL DEVELOPMENT AS DETERMINED BY DR. T. M. ROTCH 126

MICROSPLANCHNIC PHYSICAL TYPE AS DESCRIBED BY NACCARATI 162

MACROSPLANCHNIC PHYSICAL TYPE AS DESCRIBED BY NACCARATI 162

TYPICAL CASE OF CRETINISM 186

ILLUSTRATION OF BENEFICIAL EFFECTS OF THYROXIN TREATMENT. PHOTOGRAPH AT LEFT SHOWS CHILD AT THE TIME THYROXIN TREATMENT WAS BEGUN. PHOTOGRAPH AT RIGHT SHOWS SAME CHILD ONE YEAR LATER. INCREASE IN HEIGHT, SIX INCHES . . 210

ILLUSTRATION OF A CASE OF FEMINISM IN A MALE. GENITALIA ABNORMALLY UNDEVELOPED 256

FIGURES

FIGURE PAGE

1 Percentage distribution of raw scores made by University of Minnesota freshmen in the Heidbreder Introversion-Extraversion Self-Rating Scale, September, 1926 12

2 Actual mental-growth curves of children of various degrees of brightness. (From Terman, reproduced from *The Measurement of Intelligence*, by permission of and special arrangement with Houghton Mifflin Company) 19

3 Mental growth curves for mentally superior and for average girls. (From Baldwin and Stecher) . . 28

4 Physical growth curves in height for tall, for average, and for short girls. (From Baldwin and Stecher) 29

5 Average growth curves (height and weight) for bright and dull boys. (From MacDonald) . . 40

6 Curves showing the height and weight of feeble-minded inmates of American institutions, as compared with normals, age for age. (Reproduced by permission from Goddard) 56

7 Head of idiot. (From Fowler) 81

8 Curves showing the median number of permanent teeth at each age from 6 to 14 for each of four I. Q. groups. (Based on data of Perkins) . . . 152

FIGURE PAGE

9 Curves showing the median number of permanent teeth at each age from 5 to 15 for boys classified into four levels of intelligence. (Reproduced by permission from Cattell, Harvard Monog. in Educ. No. 9, p. 79) 154

10 Curves showing the median number of permanent teeth at each age from 5 to 15 for girls classified into four levels of intelligence. (Reproduced by permission from Cattell, Harvard Monog. in Educ. No. 9, p. 80) 155

11 Percentage distribution of I. Q.'s for two groups of children, one group with diseased tonsils, the other group with normal tonsils. (Based on data from Rogers, Arch. of Psychol. No. 50, p. 29) . 185

12 Bar diagram showing percentage of blonds and brunettes rated plus (+) in each of Blackford's so-called blond and brunette traits. (Based on data from Paterson and Ludgate) 217

TABLES

TABLE PAGE

1 Grade location of 263 11-year-olds by Stanford-Binet mental age. (Terman, *Intelligence of School Children,* p. 117) 17

2 Showing agreement between 428 earlier and later tests by the Stanford-Binet. (After Terman, *Intelligence of School Children,* p. 143). Correlation between I. Q. at first test and I. Q. at second test is +.93 18

3 Median weights of St. Louis school boys distributed by grades. (After Porter, *Physical Basis of Precocity and Dullness,* p. 165) 32

4 Scatter table showing relation between weight and grade location of 2,169 boys, age 9. (After Porter, *op. cit.,* p. 163) 34

5 Average measurements of standing height and weight for three groups of children classified according to I. Q., sex, and age. (After U. S. Public Health Report, vol. 44, no. 29, July 19, 1929, pp. 1774-1775) 44

6 Coefficients of correlation between weight and Stanford-Binet mental age and between height and Stanford-Binet mental age for University of Chicago Laboratory School girls at each age from thirteen to seventeen inclusive. (After Abernethy) 51

TABLE PAGE

7 Average of physical measurements for feeble-minded boys and girls arranged according to mental age. (After Doll, *Anthropometry as an Aid in Mental Diagnosis*, p. 44) 60

8 Scatter table showing relation between physical average (average of height, sitting height, and weight measurements expressed as percentiles) and mental age for 477 feeble-minded inmates at Vineland, N. J. (Table constructed from original data given by Doll in Tables 3 and 4 of *Anthropometry as an Aid in Mental Diagnosis*). Correlation = + .31 ± .03 61

9 Mean I. Q. for retarded children classified as over-average, average, and under-average in height and in weight. (Based on data presented by N. A. Dayton, M.D., *New England J. Med.*, 1928, 199, pp. 934-938) 63

10 Percentage of 3,553 retarded public school children classified as over-average, average, or under-average in height and in weight. (Based on data presented by N. A. Dayton, M.D., *New England J. Med.*, 1928, 199, pp. 934-938) . . . 64

11 Coefficients of correlation between mental age and height and weight of 397 gifted children. (After Terman, *Genetic Studies of Genius*, vol. I, p. 168) 67

12 Distribution of height (in inches) among three groups of children, 9-11 years old,—age, race, and sex being constant in the three groups. (After Hollingworth, *Gifted Children*, p. 80) . . . 68

13 Average head size of 1,095 Cambridge University students classified by age and scholastic attainment. (After Galton, 1888) 84

TABLE PAGE

14 Showing average measurements of the width of the head of girls, age 12, classified according to school grade location. (After Porter, 1894) . . 86

15 Showing average measurements of circumference of head of white boys of American parents, classified according to age and intelligence. (After MacDonald, 1899, pp. 1058-1059) 87

16 Average circumference of head measurement of white and colored children classified by age and sex. (Constructed from MacDonald, Tables 8, 35, 61, 65; 1899) 88

17 Percentage of children in each head size group who are retarded, normal, or accelerated in school progress. (After Binet, 1910) 93

18 Showing average summed head measurements in centimeters (length and width) of 1,290 boys' and 1,274 girls' ages 6 to 14 years in Nordhausen Elementary Schools, classified by sex and estimates of scholastic ability. (After Röse, p. 761) 97

19 Correlation ratio between cranial measurements and intelligence. (After Pearson, 1906) 99

20 Scatter table showing relationship between officers' ratings of the intelligence of 935 Bavarian soldiers and head size. (After Pearl's Reconstruction of Data of Eyerich and Loewenfeld, 1906) . . 101

21 Average head measurements for three groups of children classified according to I. Q., sex, and age. (After U. S. Public Health Report, vol. 44, no. 29, July 19, 1929, pp. 1774-1775) 116

22 Showing relation between shape of head and intelligence for Washington, D. C., boys. (Constructed from MacDonald, 1899) 119

TABLE PAGE
23 Showing relation between shape of head and intelligence for Washington, D. C., girls. (Constructed from MacDonald, 1899) 119
24 Head shape and scholastic ability of 2,805 6 to 14 year old children in the Catholic Elementary School in Dresden. (From C. Röse, 1906) . . 120
25 Coefficients of correlation between carpal age, number of permanent teeth, and intelligence quotients for 62 girls and 40 boys. (Lowell and Woodrow, Ped. Sem., 1922, 29, 1-15) 130
26 Coefficients of correlation between anatomical index and mental age for six homogeneous age groups. (Prescott, Harvard Monographs in Education, 1923, Series 1, No. 5) 131
27 Coefficients of correlation between ossification ratio and mental age for 220 boys and 220 girls of the ages 7 to 17 inclusive. (Freeman and Carter, *J. of Educ. Psychol.,* 1924, 15, 257-270) 132
28 Coefficients of correlation between physical traits and various maturity indices. (After Gates, *J. of Educ. Psychol.,* 1924, 15, 329-358) 135
29 Data relative to the onset of puberty in boys. (After Crampton, *Am. Phys. Ed. Rev.,* 1908, Vol. XIII) 139
30 Showing median number of teeth according to C. A. for each of four I. Q. groups. (After Perkins) 151
31 Coefficients of correlation between dentition and mental age for unselected American school children of North European descent. (After P. Cattell) 156
32 Summary of S. Naccarati's reported coefficients of correlation between the height-weight index and

TABLE PAGE

intelligence and between the morphologic index and intelligence 163

33 Summary showing mean coefficients of correlation between teachers' estimates of intelligence and various physical traits. (Heron, Cambridge Univ. Press, 1910) 171

34 Per cent of dull, normal, and bright pupils suffering from each sort of defect, ages 10 to 14 inclusive. All grades. (After Ayres, *Laggards in Our Schools*, p. 125) 178

35 Showing distribution of I. Q.'s for two groups of children, one group containing those suffering from diseased tonsils, the other group containing those with normal tonsils. (After Rogers, Archives of Psychol., No. 50, p. 29) 184

36 Distribution of glandular cases classified according to diagnosis together with data on I. Q.'s for each diagnostic group. (After Fox) 190

37 Effect of glandular therapy upon I. Q. (After Fox) 191

38 Percentage distribution of sixth grade boys and girls classified as possessing or not possessing enlarged glands on the Otis Tests scored on the basis of percentiles. (Olesen and Fernald, U. S. Public Health Reports, 41, pp. 971-986) . . . 193

39 Otis I. Q. in relation to estimated intensity of Hookworm Infection. (Smillie and Spencer, *J. of Educ. Psychol.*, 1926, pp. 314-321) 196

40 Scatter table showing relation between intensity of Hookworm Infection and Otis I. Q. for 117 children. (Smillie and Spencer, *J. of Educ. Psychol.*, 1926, pp. 314-321) 197

TABLE PAGE

41 Results of experiment by Kohnky to determine the effect of dental treatment upon the physical and mental efficiency of school children. (Constructed from data given by Kohnky) 203

42 Percentage of blonds and brunettes rated plus (+) in each of Blackford's so-called blond and brunette traits. (After Paterson and Ludgate) . 216

43 Showing average morphological index (and S. D.) for college students subdivided on basis of score on the Woodworth Personal Data Sheet. (Naccarati and Garrett) 223

44 Coefficients of correlation between physique (morphological index and Ht/Wt ratio) and emotional stability (Woodworth P. D. Sheet) and social intelligence (George Washington Test). (After Garrett and Kellogg) 225

45 Coefficients of correlation between morphologic measurements and personality trait ratings. (After Sheldon) 226

46 Classifications of body types. (After Wertheimer and Hesketh) 232

47 Principal average measurements of Kretschmer's Three Physical Types 233

48 Classification of manic-depressive patients (Circulars) and dementia praecox patients (Schizophrenes) according to physical type. (Kretschmer) 236

49 The temperaments. (Kretschmer) 239

50 Showing the percentage distribution of manic-depressives and schizophrenes according to Kretschmer's body types. (After Wertheimer and Hesketh) 244

TABLE PAGE
51 Coefficients of correlation between saliva and urine biochemical analyses and personality ratings—39 undergraduates. (After Rich) 252
52 Coefficients of correlation between saliva and urine biochemical analyses and personality ratings—18 graduate students. (After Rich) 253
53 Coefficients of correlation between biochemical analyses of blood and personality ratings—303 behavior clinic children. (After Rich) . . . 253
54 Masculinity ratings of control and gifted children, by sex. (From Terman, 1925) 258
55 Masculinity ratings (play interest indices) of University freshmen (men and women). (From Ulvin, 1927) 260
56 Distribution of scores of University freshman men and women in sports information test. (From Ulvin, 1927) 261
57 Distribution of shoulder width measurements (height held constant) of University freshman men and women. (From Ulvin, 1927) . . . 263
58 Distribution of hip width measurements (height held constant) of University freshman men and women. (From Ulvin, 1927) 264

PHYSIQUE AND INTELLECT

Chapter I

PRELIMINARY CONSIDERATIONS

1. Introduction

SCIENTISTS and laymen alike have long suspected the existence of significant relations between mental traits and physical traits. To what extent are these surmises justified? In what particulars are they true? To formulate answers to these questions in the light of present scientific evidence constitutes the purpose of this book.

Some sort of answer has been given to these questions in almost every age, but not often through the verdicts of scientific experimentation. Without waiting for the slow but sure answers of science man has fashioned for himself such plausible answers, shrewd or shallow, as have been handed down from generation to generation in the form of tradition and belief. Except by this pedigree, how account for the popular phrase "high brow" to designate intelligence of the academic variety? Or the phrase "long headed" to characterize the man who plans for the future in a far-sighted way. Belief in a positive relationship between size of head and intelligence accounts for the typical caricature of the man of great intellect depicted with a massive head set upon a small body. Closely allied with this view, is a widespread notion that a precocious child or a child prodigy is the unfortunate possessor of a puny and weak body, is deficient in normal play interests, and is likely to be high-strung or nervous. Conversely, many visualize the mentally deficient person as being big and strong. Witness the phrase, "a weak mind and a strong back." Newspaper headlines play up the "moron criminal" as some sort of savage beast.

The history of science itself is strewn with theories of the relation between physical and mental traits. Many of these theories persist today as pseudo-scientific doctrine, while others legitimately survive awaiting empirical verification. Still other theories have been modified and shaped to fit the facts disclosed by adequate research study.

Among the various theories or systems of thought upon this subject we may mention phrenology. Phrenology is long since discredited in scientific circles, for it holds that signs of mental functioning are to be found in such external criteria as depressions and protuberances of the skull. Then there is the numerous family of fearfully complex systems of physiognomy, perhaps originally outlined and to some extent standardized by Aristotle. It persists throughout the ages and is flourishing now in both crude and elaborate forms in what Jastrow [1] calls the psychological underworld, wherein pseudoscience is king. These plausible doctrines give rules for judging human character on the basis of size and shape of the face, skin texture, complexion, etc. It is true that scientific study has not yet canvassed all the seductive assertions put forth by the physiognomists. Such studies as have been made, however, present us with monotonously negative results.[2] Nevertheless, scientific caution compels us to admit the possibility of salvaging a few kernels of truth from these pseudo-sciences.[3]

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[1] Joseph Jastrow, *Fact and Fable in Psychology* (Houghton Mifflin Company, Boston, 1900), pp. 1-371.

[2] G. U. Cleeton and F. B. Knight, "Validity of Character Judgments Based on External Criteria," *J. of Applied Psychol.*, 1924, 8:215-231.

[3] F. H. Woods, "What is There in Physiognomy? I. The Size of the Nose," *J. of Heredity*, 1921, 12:301-318. "The majority of great men have large or long noses, the remainder nearly always have noses of at least

From the time of Galton's observations that men of genius tend to be above average in height and weight [4] to the present time, there has been study after study, some asserting and some denying a striking correlation between stature, weight, and intelligence. Frequently these studies include elaborate treatment of height and weight data combined to yield indices of body build. A few studies relate these measurements to a great variety of bodily lengths and dimensions, obtaining highly complicated morphological indices. All this work may be classified under the head of morphological theories of intelligence and temperament. In subsequent chapters we shall review these studies in the attempt to discern whatever relationships can be demonstrated with satisfactory probability.

Less numerous than the foregoing are those studies which undertake to determine relationship between anatomical and physiological development and mental ability. Stages of teeth eruption, stages in the appearance of characteristics indicating the onset of puberty, and stages in the ossification of wrist bones represent the main indices of physical development used in this group of studies. These investigations throw light upon anatomical and physiological theories of intellect.

Belief that a sane mind can only exist in a sound body has led many to search for the relation between physical defects and mental ability. It was expected, for example, that defec-

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average size." Also, Truman Lee Kelley, *Interpretation of Educational Measurements* (World Book Co., New York, 1927), pp. 107-108. Speaking of physiognomy Kelley states: "None of these methods have established themselves as having more than the faintest suggestion of validity. The writer finds it hard to believe that this will always be so, and, in truth, expects that some day the analysis of mental ability and of emotional characteristics will be clearly furthered by quantitative and qualitative measures, facial contours, and expressions."

[4] Francis Galton, *Hereditary Genius* (First edition 1869, reprinted by Macmillan and Co., Ltd., London, 1925), p. 321.

tive tonsils would adversely affect mental development. We must inquire into the correctness of this belief and then proceed similarly to take up the question of the extent to which other physical defects, including malnutrition, are associated with defective mental development.

Throughout many of these studies we find explicit acceptance of the proposition that mankind is sharply classifiable into both physical and mental types and that these are interrelated in definite patterns. This phase of our problem, and particularly examination of the experimental methods involved, cannot be neglected.

2. The Necessity for Accurate Measurements and Adequate Statistical Methods

Many of the studies reported in the scientific literature, we are to deal with, issue in conflicting results. A somewhat bewildering state of affairs is the result. This is due, primarily, to the use of faulty techniques, which characterize pioneering efforts in any new field of science. As the trails are blazed, stumbling-blocks are uncovered and removed. The later investigators profit from mistakes of their predecessors and renew the effort with sharpened instruments. They employ better tools of analysis, and interpret with improved logic. Thus, results which at first seemed to be in conflict are found to be in harmony, and the growing mass of evidence discloses a logical and consistent pattern.

Many people, even to-day, do not realize the necessity for precision in observation and measurement. It is easy to forget that the observation of even simple phenomena is likely to involve gross error. Sir Charles Goring[5] has presented striking evidence on this point. Incidentally, his data threw needed light upon beliefs concerning the intellectual significance of a high forehead ("highbrow"), or a low forehead ("lowbrow").

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[5] Sir Charles Goring, *The English Convict* (Pub. by H. M. Stationery Office, 1913), pp. 28-29.

Goring secured a rating or estimate of (a) intelligence and (b) height of forehead for each of 300 convicts. These ratings were made by the warden and prison physician. Four grades of intellect were discriminated in assigning ratings of intelligence. These ranged from "intelligent" down to "imbecile." There is reason to believe that the estimates of intelligence possessed fair validity, since the raters had had ample opportunity to observe the behavior of these convicts in the process of assigning each to a suitable occupational task, some being found to be so feeble mentally as to be incapable of handling even the simpler types of work.

From Goring's results it appears that 20.5 per cent of the group judged "intelligent" were also judged to have high foreheads, whereas only 8 per cent of those judged "imbecile" were judged to have high foreheads. Only 20.5 per cent of the intelligent group were judged to have low foreheads, whereas 46 per cent of the imbecile group were so judged. In the two intermediate intelligence groups the results were in harmony. Altogether there seemed to be a marked tendency for the more intelligent to have high brows and the less intelligent to have low brows.

It so happens that Goring actually measured the height of the foreheads of each of these 300 criminals at a later date, thus securing precise anthropometric measurements. These measurements were then plotted according to the four intellectual grades previously determined with the following result:

INTELLECTUAL GROUP	MEDIUM HT. OF FOREHEAD
Intelligent	50 mm.
Unintelligent	52 mm.
Weak-minded	54 mm.
Imbeciles	53 mm.

Thus no positive correlation really exists between intelligence as estimated and height of forehead as actually measured. Indeed, fourteen of the most intelligent group were found to have lower foreheads than any of the imbeciles. It seems to be true that the bright looking convict or the convict known to be intelligent was judged to have a high brow and the weak-minded to have a low brow without regard to objective facts as revealed by measurement of the actual heights of foreheads. These data reveal the existence of a constant error in the estimation of height of forehead due no doubt to the conscious or unconscious acceptance on the part of the judges of the widespread belief in the intellectual significance of a high brow or a low brow. Not only do these data explode such a belief, but they also illustrate that human judgment may be seriously in error in estimating such a simple, observable linear trait as height of forehead. Goring, of course, utilizes these data in arguing for precise physical measurement against the type of casual observation upon which so much of the work of the ill-fated Lombrosian school of criminal anthropology depended.

The psychologist is forced to use estimates of mental traits in many experimental situations. Nevertheless, he insists that scales or tests for measuring mental traits rather than estimates should be employed whenever such scales or tests are available. Much psychological research work has been devoted to the determination of the validity of estimates.[6] The generalization is certainly warranted at this time, since estimates of psychological traits on the basis of casual observation and brief acquaintance are extremely unreliable and possess little or no scientific validity.[7]

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[6] The best summary is H. L. Hollingworth, *Judging Human Character,* (D. Appleton and Company, New York, 1923). For more technical papers on the subject consult H. L. Hollingworth, "Experimental Studies in Judgment," *Archives of Psychology*, No. 29, Columbia University.

[7] Cleeton and Knight, *op. cit.* Also Hollingworth, *op. cit.*

Suspicion may properly be directed toward investigations that attempt to determine the relation between mental traits and physical characters and yet fail to utilize precise measurement, either physical or mental. But even where measurement techniques are safe against legitimate criticism, we must still be on guard against conclusions drawn from physical and mental data where proper statistical methods of analysis or proper controls are lacking. For example, the subtle influence of selection of subjects can easily invalidate the apparent relationships reported. Again all data must be scrutinized with an eye to the possibility that some third variable is lurking in the background and is, in reality, responsible for the observed relationship between a physical and a mental trait. This requires the use of partial correlation techniques or, better still, experimental control coupled with great caution in assertion of causal relationship where only association may have been found.[8]

3. The Necessity of Withstanding the Temptation to Classify Mankind into "Types"

Much of our thinking about human beings is fallacious because of our tendency to pigeonhole and classify. There is a strong urge to classify mankind into types, physically, and mentally. The dramatic quality of the exceptional trait captures attention, and straightway one is on the lookout for additional examples to add to the observation. As new examples come to light their frequency becomes impressive and it is quickly inferred that a considerable number of human specimens belong in that particular category. Here is science in the embryonic stage of classification, and many times it is not much superior in refinement to the efforts of the small boys of a past generation who strenuously contested with one another the number of white horses they could observe and tabulate.

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[8] For an excellent discussion of these points see Barbara S. Burks' chapter on "Statistical Hazards in Nature-Nurture Investigations," Part I *The 27th Yearbook of the National Society for the Study of Education* (Public School Pub. Co., Bloomington, Illinois, 1928), pp. 9-33.

Errors arising in type classifications are due to a variety of logical fallacies in reasoning. The fallacy of false simplicity leads the uncritical to believe that traits or combinations of traits are discontinuous and simple in organization, whereas they are more likely to be continuous and may be exceedingly complex in their interrelations. The fallacy of verbalism is prevalent even in much supposedly scientific thinking. Naming a thing, for some, constitutes proof of its invariable existence as an entity. This fallacy is due to a failure to use quantitative methods for reporting the variability of qualities and traits. The fallacy of the particular case is another source of error in which one finds what one is looking for. It need only be mentioned to be recognized as a prolific source of error against which rigorous scientific procedure must be adopted.

The tendency to classify mankind into types was quite prevalent in the earlier history of psychology and under camouflage it continues to appear in the present. Thorndike[9] must be given credit for his keen exposé of the fallaciousness of type classifications. Many type theories, of course, arise from a belief in compensation in mental traits. For example, the belief was widely held that the greater the development of an individual's visual imagery, the more restricted would be the development of imagery in other sense fields. But Thorndike demonstrated correlation and not compensation to be the rule in human nature.

In the earlier studies of imagery certain individuals were discovered who were able to arouse a vivid visual image of a scene but could not image the smell of a rose or the sound of a whistle. These were pigeonholed as visualizers. Others were discovered who were relatively better in auditory imagery than in other kinds of imagery and were classified as audiles. Still others were labeled as motiles (good in getting motor images), or as tactiles (good in tactual imagery). These cases were thought to establish the principle that the mass of mankind was classifiable into one or the other of these image groups. When individuals were found who could not be so pigeonholed it was only necessary to construct an intermediate category such as visual-auditory types. But soon additional intermediate classifications were required, and finally psychology was left with a bewildering variety of pigeonholes with little notion as to the relative frequency of each. Betts in 1909 proceeded to measure a number of individuals with reference to the vividness of imagery in all sense-fields. Thorndike comments on Betts' findings as follows: "Instead of distinct types, there is a continuous gradation. Instead of a few 'pure' types, or many 'mixed' types, there is one type—mediocrity. Instead of antagonism between the development of imagery from one sense and that from other senses there is a close correlation."[10] Here we have the gist of Thorndike's single type theory as opposed to multiple type theories. This single type theory "joins all men one to another in a continuity of variation and describes a man by stating the nature and amount of his divergences from the single type."[11]

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[9] E. L. Thorndike, *Educational Psychology*, vol. III. "Individual Differences," Chap. XVI (Teachers College, Columbia University, 1914).

Even when dealing with such contrasting terms as "introvert" or "extravert" as employed in the literature of psychopathology, if one is aware of Thorndike's teaching he would be loathe to believe that men are classifiable as either "introvert" or "extravert." Measurements of these traits based upon symptoms gleaned from the clinical literature show that these terms are truly descriptive only of the extremes of a continuous distribution with the intermediate steps most frequently encountered.[12] Measurements derived from Heidbreder's revised "Extraversion-Introversion Self-Rating Scale" secured for all entering freshmen at the University of Minnesota yield a percentage frequency distribution for the class entering in 1926 shown in Figure 1.

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[10] E. L. Thorndike, *op. cit.*, p. 374.

[11] *Ibid.*, p. 376.

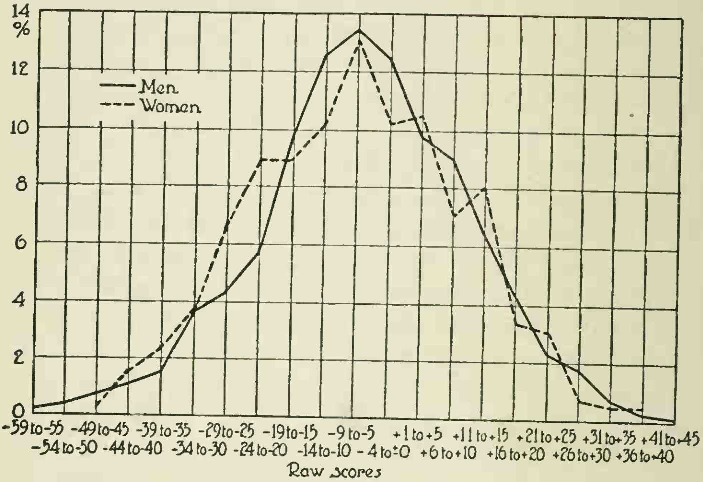

FIG. 1.

Percentage distribution of raw scores made by University of Minnesota Freshmen in the Heidbreder Introversion-Extraversion Self-Rating Scale. September, 1926.

This general phenomenon of continuity of variation coupled with the fact of positive correlation among human traits (this extends even to the relation between diverse physical and mental traits) makes the existence of multiple types very improbable. The vagueness and lack of adequate evidence which characterize the generalizations of multiple type thinkers are a block to progress and are greatly to be deplored for that reason. Nothing has been discovered since Thorndike's enunciation of his single-type theory to give comfort to the busy classifiers. Indeed, the tremendous increase in quantitative studies and the spread of refined statistical competence among investigators since 1914 has everywhere tended to yield results confirming the theory of one type, that of mediocrity.

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[12] E. Heidbreder, "Measuring Introversion and Extraversion," *J. of Abnormal and Social Psychol.*, 1926-27, 21:120-135.

4. Measures of Physical Traits

The physical and physiological measures to be referred to in our subsequent discussion have been described in numerous anthropometric and psychological testing manuals. A mere listing of them at this point will serve as an introduction to the experimental studies themselves.

The technique of cranial measurements, and height and weight are described in various manuals. The psychology student will perhaps be most familiar with Whipple's Manual.[13] Woodrow gives a good description of the technique in which eruption of teeth is taken as an index of physical development. His norms are derived from the data of James and Pitts.[14] Woodrow also gives a summary of the age and sex standards for pubescence based on Crampton's work.[15]

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[13] G. M. Whipple, *Manual of Mental and Physical Tests*, vol. I, Ch. IV. (Warwick & York, Inc., Baltimore, 1914).

[14] H. Woodrow, *Brightness and Dullness in Children* (J. B. Lippincott, Phila., 1919), pp. 101-104. Also James and Pitts, "Some Notes on the Dates of Eruption in 4,850 Children, Aged under Twelve," Proceedings of the Royal Society of Medicine, vol. V, 1912.

[15] H. Woodrow, *op cit.*, p. 109, also C. W. Crampton, *Anatomical or Physiological Age Versus Chronological Age*, Pedagogical Seminary, 1908, 15:230-237; and "Physiological Age," *American Physical Education Review*, 1908, 13:141-154, 214-227, 268-283, and 345-358.

For descriptions of a measurement technique in determining degree or stage of ossification of the carpal bones of the wrist and the epiphyses of the radius and ulna, and especially the development of the ossification ratio technique (area ossified in relation to total wrist area automatically discounting variations in ossified area due to variations in size of hands), see work of Gates, Carter, and Prescott.[16] Indices of body build as related to intelligence are described in the work of Naccarati.[17] Nutritional status is measured in terms of deviations in weight from established standards of weight in relation to height, age, and sex.[18]

5. Measures of Intelligence

It is not our intention to enter here into a discussion of the scientific controversies aroused by the advent of intelligence tests, but rather merely to list the measures which have ordinarily been used and to present some of the evidence tending to confirm the reliability and validity of the more generally accepted measures.

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[16] A. I. Gates, "The Nature and Educational Significance of Physical Status and of Mental, Physiological, Social, and Emotional Maturity," *J. of Educ. Psychol.*, 1924, 15:329-358; F. N. Freeman and T. M. Carter, "A New Measure of the Development of the Carpal Bones and Its Relationship to Physical and Mental Development," *J. of Educ. Psychol.*, 1924, 15:257-270; J. C. McElhannon, "The Invalidity of the Inspectional Method of Ranking Radiographs of the Carpal area of the Wrists," *J. of Educ. Psychol.*, 1926, 17:77-85; T. M. Carter, "Technique and Devices Used in Radiographic Study of the Wrist Bones of Children," *J. of Educ. Psychol.*, 1926, 17:237-247; D. A. Prescott, "The Determination of Anatomical Age in School Children and Its Relation to Mental Development." Cambridge, Harvard Monographs in Educ., 1923, Series I, no. 5.

[17] S. Naccarati, *The Morphologic Aspect of Intelligence* (Archives of Psychol., no. 45, 1921), pp. 1-44; also H. E. Garrett and W. N. Kellogg, "The Relation of Physical Constitution to General Intelligence, Social Intelligence, and Emotional Instability," *J. of Exper. Psychol.*, 1928, 11:113-130.

[18] See Gates, *op. cit.;* also J. L. Hunt, B. Johnson, and E. M. Lincoln, *Health Education and the Nutrition Class* (E. P. Dutton & Company, Inc., New York, 1921), pp. 1-281.

In earlier studies investigators relied upon the age-grade location of children in school as an index of mental ability. Since this criterion itself has proven to be one of the most acceptable standards for validating standard intelligence tests, it can be accepted also as a fairly good index of mental ability. In these earlier studies the relation between height and weight and the grade location of children classified by chronological age groups was sought. The results of these studies are somewhat questionable because of the well-known tendency to promote children on the basis of size as well as on the basis of intellectual ability and achievement. It is just this error in the criterion of age-grade location which assumes great importance in such height and weight studies. Nevertheless, the extremely high correlations between our standard intelligence tests and grade location (with chronological age constant) would indicate the general validity of the latter as an index of mental ability.

Teachers' estimates of intelligence also have been used in some of the studies. It must be admitted that such estimates are not completely satisfactory. Many known errors enter into them. The most important perhaps is the "halo" effect.[19] Briefly, this error arises because general impressions tend to predominate and to incapacitate the person judging for distinguishing the specific details upon which a correct analytical judgment must be based. Teachers, unconsciously subject to this "halo" effect, permit general attitudes toward pupils to color their estimates of intelligence. Another error, known technically as "the central tendency of judgment," leads many teachers to overestimate the intelligence of older, retarded pupils and to underestimate the intelligence of younger, accelerated pupils.

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[19] E. L. Thorndike, "A Constant Error in Psychological Ratings," *J. of Applied Psychol.*, 1920, 4:25-29.

Of the available standardized intelligence tests, the Stanford Revision of the Binet Tests has won for itself first rank position. Psychologists generally accept measurements with this scale if made by competent examiners as a highly reliable and valid measurement of absolute intelligence or mental age (M.A.) and when related to chronological age (C.A.) as an equally reliable and valid measurement of relative intelligence or brightness (Intelligence Quotient or $\text{I.Q.} = \frac{\text{M.A.}}{\text{C.A.}}$).

The validity of the Stanford-Binet test is shown by high correlations between mental age and grade location keeping chronological age constant by experimental control.[20] These correlations are in the neighborhood of +.80, which is remarkably high in view of many known errors influencing grade location and tending to lower the correlation much more often than to raise it. The scatter table giving the detailed data for one age group is shown in Table 1.

The reliability or consistency of repeated tests of the same children is demonstrated by coefficients of correlation in the neighborhood of +.85 to +.90. That is, I.Q.'s of children of both sexes and various ages correlate about +.90 with I.Q.'s of the same children when retested one, two, or three, years later. Dickson has summarized the results of thirteen geographically separated investigations of the constancy of the I.Q. and shows that these all tend to confirm Terman's original study.[21] This original exploration was based upon 315 children retested one or more times, yielding 428 retest

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[20] L. M. Terman, *The Intelligence of School Children* (Houghton Mifflin Company, Boston, Mass., 1919), 116-120.

[21] Virgil Dickson, *Mental Tests and the Classroom Teacher* (World Book Company, New York, 1923), pp. 65-71.

TABLE 1

Grade Location of 263 11-Year-Olds by Stanford-Binet Mental Age. (After Terman, *Intell. of School Children,* p. 117.) Note: Chronological age of all children in table is eleven years. Correlation is + .81.

	SCHOOL GRADE								
Mental Age	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*Total*
18	..	..	..	..	..	..	1	..	1
17	..	..	..	..	..	..	3	1	4
16	..	..	..	..	..	1	2	..	3
15	..	..	..	..	2	5	6	1	14
14	..	..	..	1	6	13	2	..	22
13	..	..	..	3	12	18	1	..	34
12	..	..	1	2	22	12	..	..	37
11	..	..	2	10	42	6	..	..	60
10	..	..	6	15	20	1	..	..	42
9	..	2	3	14	6	..	..	..	25
8	1	5	6	2	..	..	..	..	14
7	1	1	3	..	..	..	..	..	5
6	1	..	..	..	..	..	..	..	1
5	1	..	..	..	..	..	..	..	1
Total	4	8	21	47	110	56	15	2	263

comparisons, as shown in Table 2. The intervals between the tests ranged from one day to seven years, and the age at the first testing ranged from three years to over fifteen. The correlation is + .93. When the data are analytically examined, such factors as age at first testing, interval between examinations, or I.Q. level seem to have little effect upon constancy of the I.Q.[22]

The constancy of the I.Q. is revealed in a striking manner when actual mental-growth curves are plotted alongside of the mental-growth curve as it should be if the I.Q. is constant. Sample curves are shown in Figure 2. The reader may judge for himself the extent to which empirical results confirm theoretical requirements.

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[22] L. M. Terman, *op. cit.*, ch. IX, "The I.Q. as a Basis for Prediction," pp. 135-157.

TABLE 2

Showing Agreement Between 428 Earlier and Later Tests by the Stanford-Binet. (After Terman, *Intell. of School Children*, p. 143.) Correlation Between I.Q. at First Test and I.Q. at Second Test is +.93.

I.Q. at First Test	*I.Q. at Second Test*													
	45–54	55–64	65–74	75–84	85–94	95–104	105–114	115–124	125–134	135–144	145–154	155–164	165–174	*Total*
165–170 ...	..	..	..	..	..	..	..	1	..	..	..	1	1	3
155–164 ...	..	..	..	..	..	..	..	..	..	..	..	..	2	2
145–154 ...	..	..	..	..	..	..	..	..	3	4	9	..	..	16
135–144 ...	..	..	..	..	..	..	..	..	5	12	6	2	1	26
125–134 ...	..	..	..	..	..	..	..	6	19	7	1	..	..	33
115–124 ...	..	..	..	..	1	1	11	39	24	..	..	..	..	76
105–114 ...	..	..	..	..	2	10	26	21	1	..	..	..	..	60
95–104 ...	..	..	..	1	16	37	16	4	..	..	..	..	..	74
85–94 ...	..	..	1	9	30	18	6	..	..	..	..	..	..	64
75–84 ...	..	..	8	24	9	4	3	..	..	..	..	..	..	48
65–74 ...	..	3	13	4	..	..	..	..	..	..	..	..	..	20
55–64 ...	2	1	2	..	..	..	..	..	..	..	..	..	..	5
45–54 ...	1	..	..	..	..	..	..	..	..	..	..	..	..	1
	3	4	24	38	58	70	62	71	52	23	16	3	4	428

Many standard group intelligence tests of the verbal type may safely be substituted for the Binet individual test because they also yield satisfactory correlations with school success.

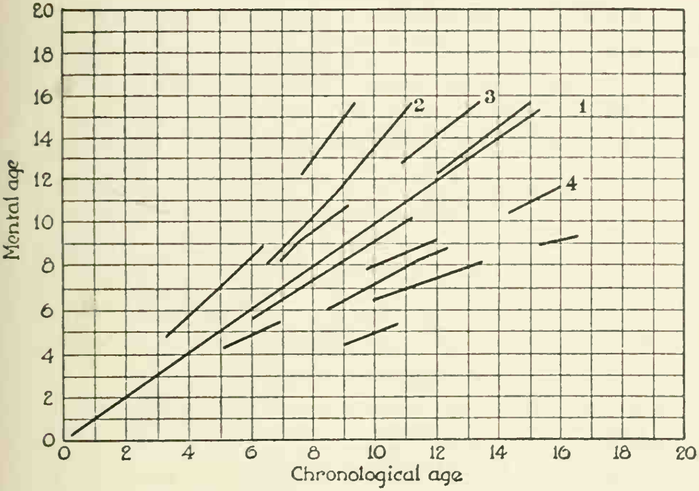

FIG. 2.

Actual Mental-Growth Curves of children of various degrees of brightness. (From Terman. Reproduced from *The Measurement of Intelligence,* by permission of and special arrangement with Houghton Mifflin Company.)

1. Mental-growth curve as it would be for a child who continued to test at 100 I.Q.
2. Mental-growth curve of grand-daughter of an inventor and related to John Wesley.
3. Mental-growth curve of son of a man of international fame.
4. Mental-growth curve of a member of a feeble-minded family of "X" County, California.

These various objective measures of intelligence may be thought of as reliable and valid indicators of abstract intellect, that is, the kind of intellect required for successful work in academic school subjects.

6. The Significance of Individual Differences in Mental and Physical Traits

The significance of the enormous range of individual differences in both physical and mental traits found in any ordinary sampling of the population even when the samples are homogeneous with respect to age, sex, race, nationality, economic and social status, and educational opportunity, is emphasized to-day as never before. This is an outstandingly important trend in modern science dealing with man. The combined resources of biological and psychological science are being mobilized for a determined effort to unravel the complexities and dissipate the uncertainties surrounding the unique characteristics of the human individual—those traits which transform a psycho-biological organism into an individual, a person.

A strong tendency to think of human problems in the mass and an equally strong desire to understand human nature as it is expressed in the lives of the millions, have combined to throw a flood of light upon the constitution and nature of *man*. But there has been a neglect of studies designed to advance knowledge and understanding of *men*. The bewildering variety of individual differences in intellect, temperament, and physique will forever challenge every resource of psychological science.

That individuals differ one from the other in height, weight, and every other physical trait is obvious. The causes of these differences, however, present problems which will find solution only through the efforts of whole armies of scientific workers enlisted under the banners of a variety of scientific disciplines. Until solutions are found the attempt to understand, predict, and control physical traits in the individual must of necessity be limited to guess work, provisional and semi-precise formulas, and pious hopes. In this book, however, interest is not restricted to this phase of the problem. We are here concerned with the possibility of discerning which physical traits, if any, bear a functional relationship to variation in mentality and temperament.

The fact that individual differences in intellect are paralleled by individual differences in physical traits suggests, but does not prove, that the former may be conditioned to a large extent by the latter. If this is so, then mental development might seem to be dependent upon physical growth. Furthermore, control of physical growth through dietetics, surgery, endocrine therapy, hygienic care in infancy and childhood, physical exercise, and public health work might afford a ready means of assuring normal mental development. Even the alluring possibility of facilitating the mental evolution of the race could be held out.

Those who stress the potency of environment to mould the developing organism, physically and mentally, tend to believe that the physical and mental characteristics of the individual are closely related, both responding to the same environmental agencies. Thus unfavorable features of the environment which might be responsible for retarded physical development would be looked upon as important in producing retarded mental development as well. Physical and mental retardation should be found associated in children subject to such unfavorable environmental conditions. Of course, the reverse would hold for favorable conditions. Proof of an intimate association between mental and physical traits would be seized upon by the environmentalist as a telling argument in support of his general position.

Opposed to these views is the theory that individual differences in intellect arise primarily from racial and familial differences in gametic constitution. Great stress is placed upon the importance of racial and family heredity. Individual differences in physical traits also are thought to be determined primarily by physical heredity. If both types of differences are so conditioned, it would not necessarily follow that they are interrelated or that there is concordant physical and mental variation in any individual. If biological heredity plays the rôle of major importance in producing individual differences in mental and physical traits (and there is an increasingly impressive mass of evidence that this is true) then solution of the problems raised in this book will contribute to the growth of the science of genetics. Precise knowledge of the interrelation of physical and mental traits is basic for the analytical prosecution of many studies in the field of heredity.

This problem is not only a matter of interest to scientists in the narrow sense, but also of special interest to the educator. Such questions as adjusting the academic load to fit the pupil and developing a wise promotion policy insuring that the mental as well as the physical powers of each child will not be overtaxed have long been of vital concern to the schoolman. These questions, in many quarters, have been approached on the basis of a belief in an intimate relation between physical and mental traits. The pedagogical importance of proper physical development has likewise been stressed. Many school organization schemes have been based in part on the asserted correlation between physical condition and health on the one hand, and mental development on the other. Unified plans and procedures, however, have not resulted, primarily because no critical synthesis of the scientific literature exists to serve as a guide. The educational and pedagogical significance of physique remains in an unsatisfactory state because of the uncertainty surrounding the topic viewed from the strict standpoint of science.

In any event, it is apparent that our proposed inquiry regarding the physical basis of mind is by no means lacking in either scientific problems, or practical applications. Fortunately, sufficient scientific progress in a number of related fields has now been made to justify an attempt at a critical synthesis. Furthermore, the need for such a synthesis is urgent since the isolated researches on various phases of the problem have been characterized by conflicting conclusions. And, strangely enough, careful scrutiny of the original data in most cases indicates that the trend of the evidence is surprisingly consistent, whereas the conflicting conclusions themselves have been the product of biassed interpretations. This state of affairs argues strongly for the need of such an attempt to clarify the issues as this chapter introduces.

Chapter II

HEIGHT AND WEIGHT IN RELATION TO INTELLECT

1. Historical Reasons for Belief in Close Correlation Between Physical Status and Intellect

SIR FRANCIS GALTON'S assertion that men of genius tend to be above average in height and weight has exerted great influence during the past fifty years upon research seeking to settle the question of correlation between stature and weight on the one hand and intellect on the other. His preëminent position in nineteenth century science naturally served to invest his pronouncement with the weight of authority. Because of the historical importance of his observations and also because of their interesting character, the following lengthy quotation may be chosen to place his views definitely before us:

> "There is a prevalent belief that men of genius are unhealthy, puny beings—all brain and no muscle—weak-sighted, and generally of poor constitutions. I think most of my readers would be surprised at the stature and physical frames of the heroes of history, who fill my pages, if they could be assembled together in a hall. I would undertake to pick out of any group of them, even out of that of the Divines, an 'eleven' who should compete in any physical feats whatever, against similar selections from groups of twice or thrice their numbers, taken at haphazard from equally well-fed classes. In the notes I made, previous to writing this book I had begun to make memoranda of the physical gifts of my heroes, and regret now, that I did not continue the plan,

> but there is even almost enough printed in the appendices to warrant my assertion. I do not deny that many men of extraordinary mental gifts have had wretched constitutions, but deny them to be an essential or even the usual accompaniment. University facts are as good as any others to serve as examples, so I will mention that both high wranglers and high classics have been frequently the first oarsmen of their years. The Hon. George Denman, who was senior classic in 1842, was the stroke of the University crew. Sir William Thompson, the second wrangler in 1845, won the sculls. In the very first boat-race between the two Universities, three men who afterwards became bishops rowed in one of the contending boats, and another rowed in the other. It is the second and third rate students who are usually weakly. A collection of living magnates in various branches of intellectual achievement is always a feast to my eyes; being as they are, such massive, vigorous, capable-looking animals."[1]

A further factor tending to emphasize the importance of stature and weight as basically related to mentality is the persistence, from early times, of a metaphysical notion of unity which when adhered to leads, in this realm, to stout belief in a causal relationship between outer structure (physique) and inner function (intellect). Hence, the persistent search for a physical basis of mind. As by no means an extreme sample of this type of thinking, take the words of C. S. Woodruff:

> "It is a fair inference, then, that if a man's body is nearly an average in all respects, height, weight, proportions, etc., there must also be an average brain and therefore a normal mind—excluding, of course, normal men who have acquired insanity. . . . It is true that the human brain weight depends upon the body weight, for many muscles require many brain cells."[2]

[1] Francis Galton, *Hereditary Genius* (1st edition, 1869, reprinted by Macmillan and Co., Ltd., London, 1925), p. 321.

[2] C. S. Woodruff, "Stature and Intelligence." *Med. Record*, 1900, 58:709.

Porter's pioneer study of the growth of 33,500 St. Louis school children in the early 1890's sought an answer to the general problem through recourse to quantitative data and issued in conclusions which emphasized a positive correlation between these two physical traits and intellectual ability. Many subsequent workers accepted his methodology and conclusions, thus perpetuating the belief in an intimate relationship between these two physical traits and intelligence.

Still another influence which tends to emphasize the possible importance of physical size as a correlate of mental ability is to be found in fairly recent startling discoveries within the field of endocrinology, especially in the growth controlling rôles of the pituitary gland and the thyroid gland. The following summary suggests some of the range of possibilities: [3]

(1) hypo-thyroidism in children gives rise to cretinism characterized by stunted physical and mental growth, and in adults to myxedema in which the patient becomes physically and mentally sluggish;

(2) hyper-thyroidism produces exophthalmic goitre with symptoms of restlessness, anxiety, emotional irritability, and rapidity in action and thought accompanied by a speeding up of all metabolic processes;

(3) hypo-pituitarism (deficient secretion of the growth promoting substance "tethelin" by the anterior lobe of the pituitary gland) in children results in a dwarfed condition with a tendency toward drowsiness and torpidity. This type of dwarfism is termed ateliosis and is accompanied by preservation of normal bodily proportions. These cases are said to exhibit normal mentality. The accompanying illustration shows a group of dwarfs and midgets the majority of whom illustrate this condition. The cause of achondroplasic dwarfs

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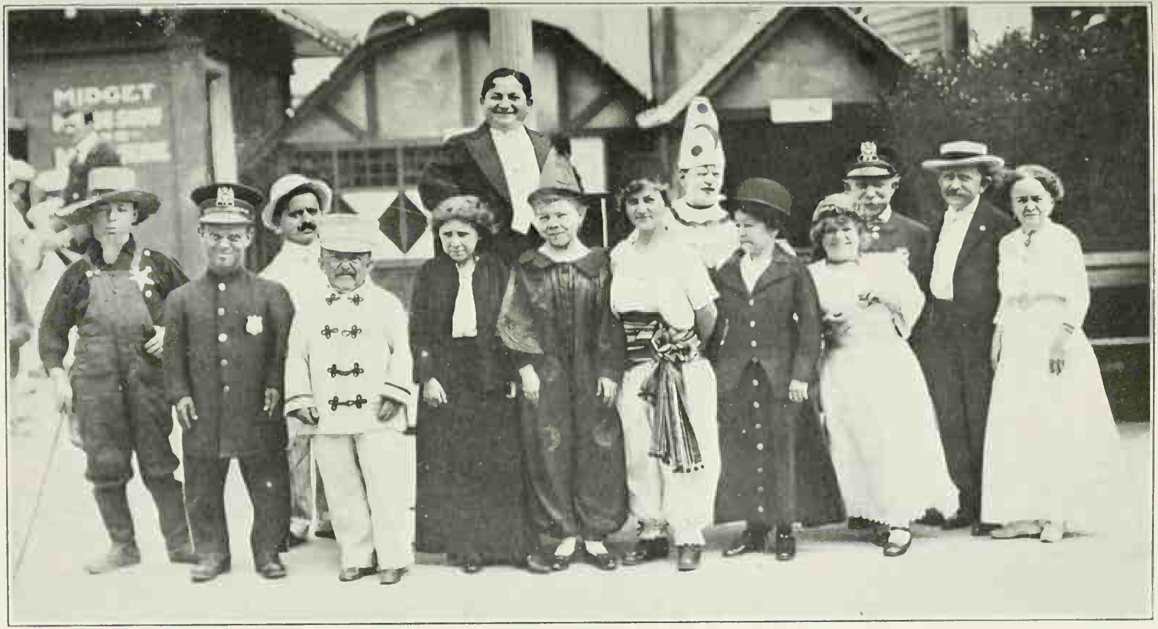
[3] This summary is based on the following: B. M. Allen, "Influence of the Thyroid Gland and the Hypophysis upon Growth and Differentiation," *J. of Heredity*, 1921, 12:414-422; C. B. Davenport, "Inheritance of Stature," *Genetics*, 1917, 2:313-389; B. Harrow, *Glands in Health and Disease* (E. P. Dutton & Company, Inc., New York, 1922), 1-218.



Photograph of a group of dwarfs and midgets exhibited at Luna Park, Coney Island, 1915. Reproduced by permission from C. B. Davenport, Genetics, 1917.

is uncertain. This type is characterized by extremely short legs, normal trunk, and large head size. Intelligence is reported as being normal, and is often quite so. Several of the dwarfs in the picture illustrate this type;

(4) hyper-pituitarism (increased secretion of "tethelin"), if present early in life, leads to gigantism; whereas if it occurs after maturity acromegaly develops, with an enlargement of the extremities so that the skeleton assumes giant-like proportions.

Since known facts point toward a mental and physical involvement as a result of abnormalities of gland functions (especially the thyroid gland) it is natural to assume that the glands of internal secretion provide a common cause which might bring about a definite correlation between body growth and mental development.

Finally, we may point to certain striking similarities in physical and mental growth which suggest at first thought that these two aspects of development are interrelated. During childhood physical growth and mental growth proceed concurrently and at a rapid rate. Furthermore, mental growth curves and physical growth curves for individual children are so similar in appearance as to make it difficult to resist the suggestion that one is a function of the other. Figures 3 and 4 illustrate this point in a striking manner.[4]

The fact that tallness or shortness is a surprisingly constant characteristic for any individual child at all ages and that brightness or dullness is likewise surprisingly constant for the individual child, in spite of rapid accelerations in both respects, naturally suggests the greater profitableness of studying the relationship between physical size and intelligence during childhood rather than later. Furthermore, the difficulty of obtaining random samples of the adult population

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[4] B. T. Baldwin and L. I. Stecher, "Mental Growth Curve of Normal and Superior Children," University of Iowa Studies in Child Welfare, 2:1-61, Jan. 1, 1922.

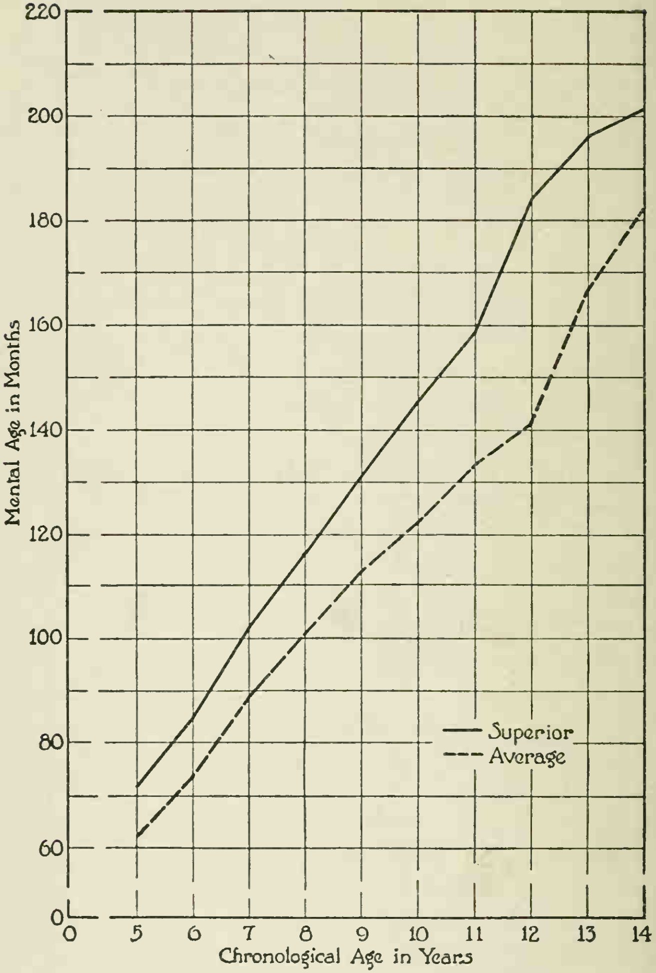

FIG. 3.

Mental growth curves for mentally superior and for average girls. (From Baldwin and Stecher.)

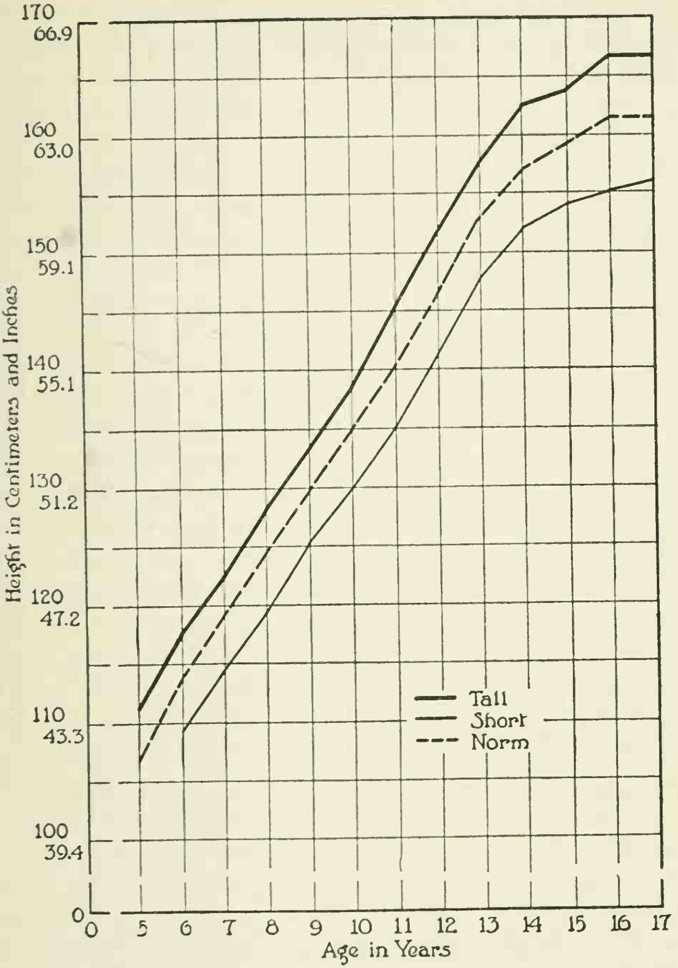

FIG. 4.

Physical growth curves in height for tall, for average, and for short girls. (From Baldwin and Stecher.)

representative of all social and economic classes in a given community, whereas such random samples of children are easily obtainable, likewise disposes us to confine ourselves largely to studies using children as subjects. In reviewing the evidence here we will attempt to ascertain the probable relationship between intelligence and height or weight among children of normal or average intelligence, among feebleminded children, and among gifted or precocious children.

2. Studies of Children

a. *Children of average intelligence.*—It so happens that two of the earliest students (Porter, a physiologist, and Gilbert, a psychologist) drew exactly opposite conclusions from independent studies of the problem. Porter held the brighter the child the taller and heavier he is, whereas Gilbert interpreted his own negative results as disproving the contention of Porter. Both studies have assumed such great importance in the history of the subject as to warrant presentation at the outset.

Porter's investigation has furnished the pattern for a number of subsequent studies tending to confirm his results. In 1892, he supervised the physical measurement of 33,500 boys and girls in St. Louis. It was his hope that this mass of data could be used to determine the laws of normal growth and that upon "this firm ground may be established a system of grading which shall take into account the physical capacity of the pupil in the apportionment of school tasks." [5]

Age-grade location was used as a measure of intelligence. Porter justifies this criterion by the statement "success in school life, like success in after life, is on the average a fair

[5] W. T. Porter, "The Physical Basis of Precocity and Dullness." Trans. of the Academy of Science of St. Louis, 1895, 6:161-181.

test of intelligence." Certainly, in one sense, Porter's position is well taken. Age-grade location has yielded in current psychological practice the best available single criterion against which standard intelligence tests can be validated. However, the fact previously pointed out that teachers tend to promote on the basis of age and size, irrespective of genuine accomplishment, detracts from age-grade location as the ideal criterion of mental ability. In this particular problem this error would tend toward spurious magnification of whatever positive relation is present.

Data for the sexes are given separately in age-grade tables which show within each cell the median weight and the number of cases for a given age and grade. For example, the median weights for nine-year-old boys in the various grades are as follows: 55.87 for grade I; 57.64 for grade II; 59.66 for grade III; and 61.75 for grade IV. It is clear that the brighter nine-year-old boys (in grades III and IV) are on the average distinctly heavier than the duller nine-year-old boys (in grades I and II). Table 3, which is copied from Porter's Table 2, *op. cit.*, p. 165, is reproduced because of its historical significance. Inspection of the tables reveals a similar trend for each and every age group. Porter concludes from these data, "They declare in unmistakable lines that precocious children are heavier and dull children lighter than the mean child of the same age. They establish a physical basis of precocity and dullness."

It is to be noted that Porter's statistical method of analysis is crude in that it prevents any statement of the *degree* of agreement between weight and precocity or dullness. Lacking knowledge of the modern method of correlation, workers in his day were compelled to present averages only, and merely to observe trends. Porter himself recognized this limitation when he stated, "How far they are applicable to individuals cannot be determined from the present data."

TABLE 3

Median Weights of St. Louis School Boys Distributed by Grades. (After Porter, *Physical Basis of Precocity and Dullness*, p. 165.) Note: Unit of Measurement is pounds; Bold-face type indicates median weight, light-face type indicates number of cases.

Age	Median Weights *Number of Cases*	*Kindergarten*	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*H.S.*
6	**43.74** N = 707	**43.58** 622	**45.29** 76								
7	**47.73** 1814	**45.55** 534	**48.48** 1205	**52.00** 59							
8	**52.58** 2188	**47.80** 28	**51.79** 1497	**54.43** 622	**57.00** 24						
9	**57.75** 2166		**55.87** 570	**57.64** 1195	**59.66** 357	**61.75** 44					
10	**62.48** 2064		**60.19** 207	**61.14** 789	**64.00** 766	**64.91** 269					
11	**68.47** 1644		**63.50** 59	**65.45** 311	**68.12** 664	**69.24** 546	**71.29** 123	**73.34** 33			
12	**73.61** 1242		**70.00** 28	**69.50** 104	**72.17** 430	**73.86** 602	**74.69** 306	**77.29** 141	**76.50** 22		
13	**79.85** 946			**74.25** 38	**75.95** 149	**78.43** 352	**80.90** 336	**82.17** 229	**83.50** 78	**82.00** 34	
14	**88.08** 498				**81.00** 46	**84.00** 184	**87.83** 194	**87.20** 242	**93.63** 143	**97.50** 88	**86.50** 25
15	**100.20** 203					**89.00** 26	**95.33** 58	**99.17** 125	**105.50** 103	**105.17** 93	**105.08** 51
16	**114.17** 71							**114.50** 25	**104.00** 23	**114.00** 60	**123.00** 66

Science demands a statement regarding not only the existence of a relationship but also its extent or amount. This can only be given by the method of correlation which discloses the precise amount of agreement existing between the two traits as measured in the individuals under observation.

Unfortunately, Porter's data are not given in such a way as to permit the computation of coefficients of correlation. This is true of practically all subsequent investigators using age-grade location, and hence a great mass of accumulated data cannot be salvaged by refined statistical analysis. It is possible, however, to apply the correlational method to a small fragment of Porter's data, since he reported, as illustrative material, complete grade-location data in relation to the weight of each of his 2169 nine-year-old boys. The derived scatter diagram is shown in Table 4. The actual Pearson product moment coefficient of correlation is +.06 ±.014. If this be taken as typical of the probable amount of relationship present in the entirety of Porter's data, it is so slight as to invalidate the emphatic claim for physical status as a factor to be considered in promoting children from one grade to another. Instead of proving a close relationship as he thought, the actual relationship on the basis of refined analysis turns out to be so negligible as to warrant the conclusion that physical development and mental ability are in reality independently variable.

How deceiving *averages* may be when unaccompanied by measures of variability is beautifully illustrated by the trend of the averages given above which exists even when the two variables, weight and grade location, are almost completely independent of each other ($r = +.06$). The reason becomes quite clear from inspection of the original data. As may be seen in Table 4, the overlapping is tremendous, the distributions of weight for each of the grades being almost identical, and only a slight difference in the averages being observable.

Of course, by restricting attention to averages alone the trend appears to be pronounced, but now it has long since been discovered that we must more completely describe our data and especially must scrutinize them for variability as well as central tendency. Had the method of correlation as an instrument of analysis been generally available in the early 1890's, much unsupported assertion and faulty technique regarding the relation between physical traits and intelligence would have been avoided, and thousands of hours of scientific labor could have been directed to more fruitful channels. The demonstration, here given, of the existence of only a slight relationship in Porter's own data should do much to

Table 4

Scatter Table Showing Relation Between Weight and Grade Location of 2169 Boys, Age 9. (After Porter, *op. cit.*, p. 163.)

r = + .06 ± .014

School Grade

	I	*II*	*III*	*IV*	*V*	*Total*
86–90	...	2	...	..	..	2
81–85	1	2	3	..	..	6
76–80	...	10	8	2	..	20
71–75	8	24	15	4	1	52
66–70	17	93	36	6	..	152
61–65	99	236	90	13	1	439
56–60	155	334	91	10	..	590
51–55	169	343	81	6	1	600
46–50	86	122	21	3	..	232
41–45	29	25	5	..	..	59
36–40	5	1	5	..	..	11
31–35	1	3	2	..	..	6
Total	570	1195	357	44	3	2169
Median Weight	55.87	57.64	59.66	61.75	65.00	57.75

clear up the obscurity by which the problem is even now surrounded. The thesis is here put forward that all scientific studies of this problem from Porter's pioneer effort to the present day are in harmony in disclosing only a slight positive relationship between physical traits and mental traits.

Gilbert's effort to determine the relationship between height and weight and intelligence differs from Porter's chiefly in his refusal to accept grade location as a suitable criterion of mental ability and his substitution of teacher's judgments of general mental ability.[6] In doing so, Gilbert was forced to rely in the case of each child upon the judgment of a single teacher. He unwittingly utilized what is now generally recognized as a very unreliable criterion.

Gilbert used the same general method of averages showing for each age the average weight or average height of bright children, of average children, and of dull children. His results were not consistent from age to age. For example, at age 7 the average weight of dull children was 49.0 lbs. and of bright children was 43.3 lbs., whereas at age 11 the average weight of dull children was 66.5 lbs. and of bright children was 70.0 lbs. In seven age groups the dull children were on the average heavier than the bright children, but this relation was reversed in four age groups. Similar inconsistencies for the height measurements were found.

Closer inspection of Gilbert's methodology discloses a series of errors all of which would combine to reduce toward zero whatever positive relationship actually exists between height and weight and intelligence. If the criterion of age-grade location represents the *consensus* of a number of teachers' opinions, then the chance errors in judgment made by several teachers tend to cancel one another. If the criterion is a single teacher's judgment there is no compensatory averaging, and hence errors of judgment remain unchecked. We see this clearly in the fact that the correlation between Stanford-Binet mental age and grade-location for any given age is about +.80, whereas the correlation between the same intelligence test and teachers' estimates of mental ability drops to about +.50.

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[6] J. A. Gilbert, "Researches on the Mental and Physical Development of School Children," Yale Psychological Laboratory Studies, 1894, 2: 40-100.

A number of factors are responsible for the unreliability of teachers' estimates. Teachers tend to overestimate the mental ability of dull pupils and to underestimate the mental status of bright pupils. This error, known as "the central tendency of judgment," is descriptive of the constant tendency to locate judgments of extreme deviates toward the mean. Thus the three groups of children judged to be bright, average, and dull tend to be less sharply differentiated than they actually are with the consequence that any slight relationship between a physical trait and brightness is masked. Serious chance errors of judgment would also be present on this scale, since, in using only three grades of judged intelligence, every chance error placing a child one step away from his true class amounts to an error with a magnitude equal to 33 per cent of the scale used. Finally, when the ratings made by the teachers in the several grades are consolidated by the massing of results by age groups another error, perhaps of even greater moment, is admitted. The varying standards of judgment exhibited by the several teachers make their estimates non-comparable and hence erroneous when consolidated. These varying standards arise from the fact that some teachers tend to be lenient in their ratings, placing most children above average, whereas other teachers tend to be too severe, submitting ratings which are below average. The practical effect of these varying standards is well known to pupils who quickly detect the "hard marker" or "easy marker." From a statistical point of view a serious error is introduced when ratings are consolidated which have been secured from various teachers exhibiting these varying standards of judgment. For all these reasons, the writer is convinced that Gilbert's negative results do not establish the absence of relationship, and that his method was too subject to error to reveal whatever slight relationship may actually exist.

West, with F. Boas, in 1896, reported results from a joint study of Toronto School Children using Gilbert's technique.[7] Classroom teachers made the physical measurements and also rated the children as "good," "mediocre," and "poor" in mental ability. Such a small number of children were rated as "poor" that he was forced to use only a two step scale of intelligence. Without presenting sufficient detailed data to permit critical inspection of his results he confronts us with the conclusion, "On the whole, we may from these observations consider it safe to say that precocity bears an inverse ratio to bodily development." These results are out of harmony with the trend of all published results, although such studies as have relied upon teachers' estimates tend to come out with zero or almost zero relationship between physical traits and mental ability. The errors inherent in Gilbert's technique are equally at work in that of West. In addition, the failure to obtain even a three step mental classification from the teachers indicates that the teachers' ratings were unusually faulty. One might also point to the unsatisfactoriness of a procedure which permits untrained teachers to make and record physical measurements.

The mental and educational implications of physical measurements were emphasized heavily by MacDonald in his elaborate study of District of Columbia school children.[8] Indeed, it would seem that his valuable study of physical growth was motivated in part by the hope that the facts of physical growth would enable educators to apportion school tasks differentially in the light of each child's physical needs and thus indirectly to control mental development more effectively. This point of view is clearly shown by the following quotation:

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[7] G. M. West, "Observations on the Relation of Physical Development to Intellectual Ability, Made on School Children of Toronto." *Science*, N. S., 1896, 4:156-159.

> "Although the physical conditions upon which the activity of mind depends are so complex, and so much is still unknown, yet it can be said with almost a certainty that at those ages in which children grow rapidly there should be a corresponding reduction in the amount of study required, and this should be done even if the pupil is mentally capable of doing more, for no pupil should be developed in mind to the detriment of bodily conditions. The bright scholar, whom parents are too often inclined to push, needs it the least, especially if his physical condition is inferior to his mental. The saying that apples which ripen slowest last the longest is as true as it is homely. The systematic collection, then, of physical statistics in the public schools will furnish valuable facts for the hygienist and the educator" (p. 991).

Or again, "To establish the measure of work according to the strength of the individual is fundamental to the economy of health. This is especially true of children, but the difficulties here are greater than in adults, owing to the changes caused by growth. Overtaxing of the powers here leaves its mark generally throughout the whole future life of the child. No question, then, can be more important for the school, according to Combe, than:

(a) What is the maximum work suitable to a child in the different periods of development in its school life?

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[8] Arthur MacDonald, "Experimental Study of Children," ch. XXI, Report of the U. S. Commissioner of Education, 1897-98, 1:985-1204, Washington: Government Printing Office, 1899.

(b) Can this maximum be injurious at certain times, when all the vital force may be required for growth?" (p. 993).

Height and weight measurements were included in MacDonald's anthropological and sociological study of 16,473 white children and 5,457 colored children in the public schools of Washington, D. C. The physical measurements were made by the teachers. Among the various ratings assigned each child by his teachers was that regarding general mental ability, a three step scale consisting of bright, dull, and average being employed. As typical of the findings we reproduce the height and weight curves for bright and dull boys in Figure 5. It will be noted that the curves cross and re-cross from age to age. The absence of any consistent trend suggests that the slight differences at each age reflect sampling errors. If this be so, then we must regard MacDonald's results as indicating a zero relationship between mentality and height or weight. In view of the extremely slight differences disclosed, it is difficult to understand why MacDonald concluded so definitely that, "Bright boys are in general taller and heavier than dull boys. This confirms the results of Porter" (p. 998). As a matter of fact, MacDonald's data are more nearly in harmony with Gilbert's and do not support his own conclusion just quoted. Since MacDonald employed Gilbert and West's methodology, it is not surprising to find that his results correspond to theirs rather than to Porter's. We must bear in mind, however, that our criticisms of the technique employed by Gilbert and West apply with equal force to that of MacDonald. For this reason, we would not be justified in the conclusion that these three studies definitely establish the relationship between intelligence and height or weight as being zero. The results do suggest, however, that the association between these two sets of variables lies in the neighborhood of zero

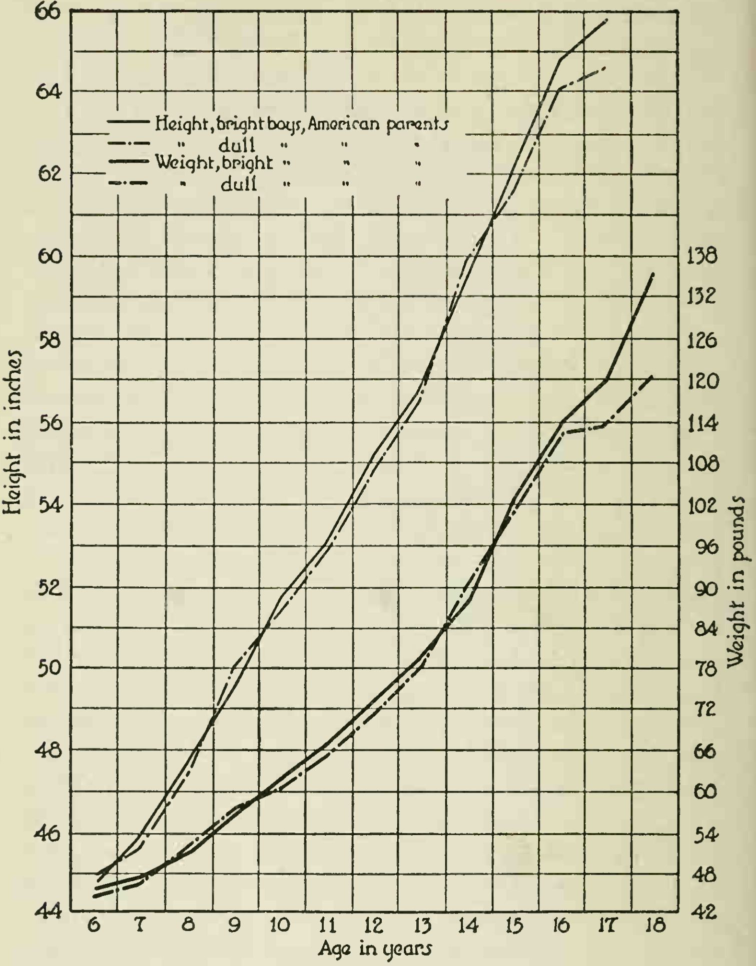

Fig. 5.

Average growth curves (height and weight) for bright and dull boys. (From MacDonald.)

and that if the true correlation should turn out to be positive it must in the nature of things be slight.

In 1900, two similar investigations, by Christopher and by Beyer, were reported, each dominated by the Porter methods and the Porter conclusions. Dr. Christopher confined his attention to 503 twelve-year-olds, attempting to determine the correlation between their physical status and grade location.[9] He presented charts for each physical trait measured (height, weight, grip, vital capacity, and ergograph performance) showing the average physical measurement of of the twelve-year-olds in each of the grades. These charts seemed to indicate a decided relationship, and so the author concluded, "Superior mental and physical qualifications are generally associated, and inferior mental and physical qualifications are likewise generally associated" (p. 684). But inadequate statistical methods were employed. Averages only were presented, with no indices of variability. It is unfortunate that the straightforward method of correlation was not utilized, since this method would automatically have taken the important factor of variability into account, and the true relationship between the physical variables and the index of brightness (grade location) would have been laid bare. An even less satisfactory attempt to confirm Porter's work was reported by Dr. Beyer.[10] His study was confined to a small group of applicants for the position of navy yard apprentice for whom physical measurements (height, weight, and chest girth) and grades in a series of school examinations were available. His statistical methods were so faulty that it would never do to place credence in his assertions of an intimate relationship between physique and brightness. That Dr.

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[9] W. S. Christopher, M.D., "Measurements of Chicago School Children," *Jr. Am. Med. Assoc.*, 1900, 35:683-687.

[10] H. G. Beyer, M. D., "The Relation Between Physique and Mental Work," *Am. Phys. Educ. Rev.*, 1900, 5:149-160.

Beyer was unduly impressed by Porter's findings is shown by his interpretation of that work: "The results of these investigations seemed to point clearly to the fact that there exists a rather close and unmistakable relationship between the weight of a child and its capacity for mental work" (p. 149).

Smedley, working in Chicago, attacked the problem by the same technique used by Porter and discussed his results as if the correlation were very high, i.e., "In general, there is a distinct relationship in children between physical condition and intellectual capacity, the latter varying directly as the former." [11] Inspection of the tables suggests no more relation than exists in Porter's data.

De Busk, in 1913, resorts to the Porter method in presenting results, in this case for only 105 boys.[12] Again we find the same sort of relationship, and no evident realization of the unreliable and erroneous impression created by slight differences in *averages*. Arnold, in 1916, continues the massing of evidence in the same way contributing additional data from four schools and reprinting for American readers similar tables covering 30,000 pupils of Sydney, New South Wales.[13] In view of our repeated criticism of the lack of meaning in such age-grade-weight tables, it may be of interest to present this quotation designed to bolster the confidence of the reader: "As over 30,000 pupils were measured, these results cannot be questioned." Stewart, in 1916, apparently satisfied with the Porter method of analysis for elementary school children, presents similar data for 207 boys in the University of Chicago training school.[14] He seems to recognize that the overlapping is too great to trust averages alone, although data to show the relationship between height and weight and intelligence for individuals are not given. In studying the same relation among 29 high school boys he adopts the method of correlation and concludes, "When individual curves and correlations are considered without reference to the size of the boy or to his stage of development, it is difficult to see any relation between physical growth and school standing."

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[11] F. W. Smedley, "Child Study in Chicago, Ill.," Report of U. S. Commissioner of Educ., 1902, 1:1095-1115.

[12] B. W. De Busk, "Height and Weight, Vital Capacity and Retardation," *Ped. Sem.*, 1913, 20:89-92.

[13] Felix Arnold, "Weights and School Progress." *Psychol. Clinic*, 1916, 10:33-39.

In 1918, Pyle reports, after the manner of Porter, the average height of 112 twelve-year-old boys classified according to grade location.[15] Those in the eighth grade are, on the average, 11 per cent. taller than boys of the same age in the first grade. It is unfortunate that the actual scattergram showing the height of each boy in relation to his grade location is not given. Only by this technique would it be possible to determine the exact amount of relationship between height as an index of physical development and grade location as a criterion of mental ability.

This review of studies employing the method of *averages* may well be concluded by citing results obtained in the recent United States Public Health Service Survey of children in County A, in Illinois.[16] This study differs from those just presented in that it utilized standard intelligence tests as the criterion of intelligence in place of age-grade-location. The children were classified into three I.Q. groups. The *averages* for standing height and weight for each I.Q. group

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[14] S. F. Stewart, "A Study of Physical Growth and School Standing of Boys." *J. of Educ. Psychol.*, 1916, 3:414-426.

[15] W. H. Pyle, "The Relation of Mental to Physical Development." *J. of Delinquency*, vol. 3, no. 5, Sept. 1918.

[16] G. A. Kempf and S. D. Collins, "A Study of the Relation Between Mental and Physical Status of Children in Two Counties of Illinois," U. S. Public Health Reports, 1929, 44:1743-1784.

TABLE 5

Average Measurements of Standing Height, and Weight for Three Groups of Children Classified According to I.Q., Sex, and Age. (After *U. S. Public Health Report*, vol. 44, no. 29, July 19, 1929, pp. 1774–1775.)

	BOYS			GIRLS		
Number Examined	*I.Q. Under 90*	*I.Q. 90–110*	*I.Q. 110 or over*	*I.Q. Under 90*	*I.Q. 90–110*	*I.Q. 110 or over*
Age 8	16	135	86	20	130	89
Age 9	43	127	70	34	129	60
Age 10	34	112	61	32	111	68
Age 11	64	93	81	48	88	75
Age 12	46	55	122	44	76	88
Age 13	41	52	66	17	58	52
Age 14	22	41	33	14	41	33
Standing Height (cc.)						
Age 8	121.94	124.61	126.60	120.15	123.86	124.60
Age 9	129.28	129.92	131.16	125.26	129.71	130.58
Age 10	132.88	134.63	135.67	133.69	133.12	136.57
Age 11	138.47	138.71	142.16	138.52	140.25	141.67
Age 12	143.13	145.09	146.32	141.32	145.72	147.60
Age 13	149.05	149.04	150.80	147.82	150.21	152.87
Age 14	150.95	156.80	156.97	151.93	153.88	157.03
Weight (kilograms)						
Age 8	23.63	25.35	26.18	23.08	24.33	24.36
Age 9	28.48	27.69	28.53	24.24	27.34	28.26
Age 10	28.66	30.15	31.23	29.61	29.56	31.41
Age 11	32.39	32.31	34.96	32.25	34.79	35.15
Age 12	35.14	37.43	37.48	34.43	37.34	38.70
Age 13	39.21	39.70	41.03	41.77	41.58	42.83
Age 14	41.31	45.54	47.13	43.31	45.02	48.07

are shown in Table 5. Scrutiny of the trend of these averages indicates that there are differences between these I.Q. groups, those with higher I.Q.'s being slightly taller and heavier than those with normal I.Q.'s or less. The differences however are very slight as compared to the large amount of overlapping in the three I.Q. groups, as the authors state. Had coefficients of correlation been computed between these physical measurements and I.Q., it is certain they would have been very low.

Bird T. Baldwin, in a series of papers, was influential in perpetuating an exaggerated view regarding the relation between physical and mental traits. In 1914 he concluded, "If pedagogical age be accepted as a fair equivalent to mental development, tall, heavy boys and girls with good lung capacity are older physiologically and further along in their stages toward mental maturity, as evidenced by school progress, than short, light boys and girls. This conclusion is based on 21,682 final term grades and 5,000 physical measurements on 125 boys and girls from the Horace Mann School at Teachers College, Columbia University and the Francis Parker School in Chicago."[17] In 1921, Baldwin reaffirms his thesis: "Physiological age is, the writer believes, directly correlated with stages of mental maturation. . . . Another experimental study just completed shows that the mental age of the individual bears a direct relationship to the physiological age as indicated by height and weight. The results show that at each chronological age the physiologically accelerated boys and girls have a higher mental age than those of the average or below the average physiological age."[18] In 1922, Baldwin states that this work of determining the interrelation between height and weight and mental development has been continued with the criterion of mental development test results on the Stanford Revision of the Binet Scale.[19] He then reports data for 49 girls showing that the correlation between height and mental age with chronological age held constant by partial correlation technique is +.53. Since this is the most definite evidence reported by Baldwin, and in fact the most striking correlation between height and mental ability on record, it is important to examine its significance carefully. In the first place, only 49 subjects were studied, a fact which suggests an unfortunately large probable error for the coefficient of correlation. In the second place, the technique of partial correlation itself contains pitfalls which may lead to false conclusions. Although, in this article, Baldwin fails to give the necessary intercorrelations between the three variables height, mental age (M.A.), and chronological age (C.A.), this additional information is published in another paper appearing in the same year.[20] All three variables are closely interrelated, as may be seen from the following:

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[17] B. T. Baldwin, "Physical Growth and School Progress," U. S. Bureau of Educ. Bulletin No. 10, 1914, Whole No. 581, pp. 215.

[18] B. T. Baldwin, "The Physical Growth of Children from Birth to Maturity," Univ. of Iowa Studies in Child Welfare, Vol. I, No. 1, June 1, 1921, pp. 196-197.

[19] B. T. Baldwin, "Relation Between Mental and Physical Growth," *J. of Educ. Psychol.*, 1922, 13:193-203.

Notation: 1 = Height; 2 = Mental Age; 3 = Chronological Age.[21]

$$r_{12} = +.89$$
$$r_{13} = +.88$$
$$r_{23} = +.88$$
$$r_{12.3} = +.53$$

The unstable character of partial correlations when all three variables intercorrelate highly and to about the same extent may be seen from additional data regarding the weight measurements of these same 49 girls. Since weight correlates +.86 with height it would be expected that weight and mental age would be related in a manner similar to height and mental age when chronological age is held constant. As

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[20] B. T. Baldwin and L. I. Stecher, "Mental Growth Curve of Normal and Superior Children." University of Iowa Studies in Child Welfare, vol. II, no. 1, January 1, 1922, pp. 56-58.

[21] Formula for the partial coefficient of correlation ($r_{12.3}$) is:

$$r_{12.3} = \frac{r_{12} - r_{13} \cdot r_{23}}{\sqrt{1 - r_{13}^2}\ \sqrt{1 - r_{23}^2}}$$

a matter of fact what appears is radically different, as may be seen from the following:

Notation: 1 = Weight; 2 = Mental Age; 3 = Chronological Age.

$$r_{12} = +.71$$
$$r_{13} = +.84$$
$$r_{23} = +.88$$
$$r_{12.3} = -.15$$

In other words although height and weight are closely correlated ($r = +.86$) and either or both may be used as an index of physical maturity yet if weight is correlated with mental age holding chronological age constant the partial correlation turns out to be negative ($r_{12.3} = -.15$). Now surely no one believes that of two equally good indices of physical status one of them correlates +.53 and the other correlates —.15 with mental age.

The difficulty arises in applying a very delicate statistical technique easily and markedly disturbed by chance errors in the original correlational data. This point may be illustrated by hypothetical data. If we assume three intercorrelations to be +.80, the partial r between any two variables with the third constant will be +.44. A chance drop of .10 points (from +.80 to +.70) between two variables (leaving the other intercorrelations at +.80) will produce a partial r of only +.17, whereas a chance increase of .10 points (from +.80 to +.90) will yield a partial r of +.72. Obviously, when dealing with heterogeneous data as regards three variables in which the intercorrelations are all high and of about the same magnitude if chance errors affecting any of these correlations by as little as .10 points produce partial correlations ranging from +.17 to +.72, we must be very cautious in making interpretations.[22] The fact that

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[22] The PE's of the *r*'s entering into Baldwin's partial correlations range from ± .02 to ± .09.

Baldwin reports a very high correlation (+.88) between chronological age and mental age for the age range considered, whereas other investigators report correlations in the neighborhood of +.80 for the same age range suggests that his partial r of +.53 is spuriously raised by chance factors.

With such a minimum of evidence and with that evidence itself shaky it is difficult to see what justification exists for Baldwin's continued adherence to belief in a strikingly close relationship between physical development and mental development. Unfortunately, his views have received wide circulation, especially among educators, through an article published in a yearbook of the National Society for the Study of Education.[23]

It is a satisfaction to report one of the most recent studies which utilizes straightforward correlation technique upon data secured in such a way as to control adequately the troublesome factor of age. Our reference is to the admirable study of Murdock and Sullivan in Honolulu.[24] This work differs from most of the previous studies in utilizing on a large scale more minutely graduated measures of intelligence, namely standard intelligence tests such as the Otis Primary Test for grades 1-3, National Intelligence Test for grades 3-9, and the Terman Group Test of Mental Ability for grades 9-12. These tests were all administered by Katherine Murdock in the capacity of school psychologist. The physical measurements were secured by Louis R. Sullivan, anthropologist representing the American Museum of Natural History in New York. In a sense it is fortunate that the physical data and the mental data were obtained in entire independence of each other and for other purposes than that of correlating the two. The subjects were some 600 pupils of old American, British, German, or Scandinavian descent constituting a "fairly homogeneous race group."

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[23] B. T. Baldwin, "Methods of Selecting Superior or Gifted Children," *Twenty-third Yearbook of the National Society for the Study of Education* (Public School Publishing Co., Bloomington, Ill., I, 1924), 25-47.

[24] K. Murdock and L. R. Sullivan, "A Contribution to the Study of Mental and Physical Measurements in Normal Children," *Am. Phys. Educ. Rev.*, 1923, 28:209-215; 276-280; 328-330.

Scores on the mental tests were converted into I. Q.'s and in a similar manner the absolute physical measures were converted into relative measures by expressing each physical measure as a quantitative deviation from the average of each age-sex group. Both techniques thus eliminate the age factor and permit direct comparison for all subjects. The chief correlations are as follows:

r between weight and I. Q. $= +.16 \pm .03$ ($N = 595$)
r between height and I. Q. $= +.14 \pm .03$ ($N = 597$)

There is thus shown to be a slight positive correlation between height and weight and intelligence. The fact that the P. E.'s are small in relation to the size of the coefficients tends to emphasize the significance of the latter. Recomputation of the correlation between weight and intelligence for boys and girls separately did not reveal any effect of lumping the two sexes together in the original computations.

The evidence obtained by McHale regarding the association between weight and intelligence is consistent with that already cited.[25] It takes on added significance, however, because this investigator made a thoroughgoing study of a number of psychological traits which might be associated with adiposity and the finding of a negligible relationship between weight and I. Q. was incidental to a comprehensive and well controlled study of overweight, normal weight, and underweight children. In all, 312 eleven-year-old children evenly divided into three weight groups were studied. Children who were 15 per cent. or more over the weight standard for their height and age were classified as over-weight; those who were within 5 per cent. plus or minus were included in the normal-weight group; and those who were 8 per cent. and below were placed in the under-weight group. The mean I. Q.'s for these three weight groups in order were 107, 102, and 102. The author properly concluded: "The results of the measurement of intelligence by the Stanford-Binet test indicated that body-weight had little to do with the possession of certain degrees of intelligence" (p. 72).

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[25] Kathryn McHale, *Comparative Psychology and Hygiene of the Overweight Child.* Teachers College, Columbia University, Contributions to Education, No. 221, 1926, especially ch. VII, pp. 66-72.

Abernethy's study of girls in the University of Chicago Laboratory Schools, likewise reveals relatively low correlations between height and weight and Stanford-Binet mental age.[26] For 120 girls between 6 and 12 years of age the partial correlation for constant age was +.34 ±.05 between height and mental age and +.39 ±.05 between weight and mental age. But when chronological age was controlled experimentally by computing the Pearson coefficient of correlation between weight and height and mental age for each group separately for ages 13 to 17 inclusive the correlations turn out to be consistently lower. The results are shown in Table 6. The small number of cases at each age is responsible for the relatively high probable errors of each coefficient of correlation, which prevent placing much credence upon the exact size of any of them. The trend, however, points to a low positive correlation between each of these physical traits and mental age for homogeneous age groups.

Finally, we may mention Gates' study published in 1924 and the study of Pearson and Moul published in 1925. Gates showed that the correlation between height and Stanford-Binet mental age is +.06 and between weight and Stanford-

[26] E. M. Abernethy, "Correlations in Physical and Mental Growth," *J. of Educ. Psychol.*, 1925, 16:458-466 and 539-546.

TABLE 6

Coefficients of Correlation between Weight and Stanford-Binet Mental Age and between Height and Stanford-Binet Mental Age for University of Chicago Laboratory School Girls at Each Age from Thirteen to Seventeen Inclusive. (After Abernethy.)

Correlation between Mental Age and:		*Chronological Age Groups*				
		13	14	15	16	17
Weight	N	44	61	29	45	37
	r	−.06±.10	+.10±.08	+.15±.12	+.21±.10	+.18±.11
Height	N	44	62	29	45	37
	r	+.01±.10	+.07±.08	+.11±.12	+.02±.10	+.25±.10

Binet mental age is +.10 for children in the kindergarten and in the fourth grade.[27] These two correlations represent the average of four correlation coefficients each with age held constant. The partial correlation technique itself was really unnecessary since each correlation was derived from very homogeneous age groups. Pearson and Moul conducted a very elaborate biometrical study of 616 alien Jewish boys and 580 alien Jewish girls residing in London and found a negligible correlation (correlation ratio) between estimated intelligence and height and weight.[28]

We may summarize the general trend of this critical review of the studies on the relation between height and weight and intelligence in normal children by stating that a slight positive correlation seems to exist between stature or weight and intelligence. The emphasis can be on either of two points: on the one hand, we would emphasize the fact that the relationship, even though slight, is positive; on the other hand, in view of the exaggerated notions which have been current in the past and which persist even at the present time, it is important to emphasize the fact that physical status and mental status are to a great extent independent of one another.

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[27] A. I. Gates, "The Nature and Educational Significance of Physical Status and of Mental, Physiological, Social, and Emotional Maturity," *J. of Educ. Psychol.*, 1924, 15:329-358.

[28] Karl Pearson and Margaret Moul. "The Problem of Alien Immigration into Great Britain, Illustrated by an Examination of Russian and Polish Jewish Children." Part II, "On the Intelligence of the Alien Jewish Children." *Annals of Eugenics*, 1925-26, 1:56-127.

b. *Feeble-minded and mentally dull children.*—There is a preponderance of opinion to the effect that feeble-minded persons are on the average markedly deficient in respect to height and weight. This trend of opinion has been surprisingly consistent from the time of the pioneer studies of Tarbell[29] and Shuttleworth[30] published during the 1880's down to studies which have appeared within the past year or so. There is one noteworthy but generally neglected exception (Norsworthy, 1906). Since it is unsafe, in science, to accept unanimity of opinion itself as proof, it is necessary to review these studies in some detail to determine the extent to which the supporting data are actually in harmony with the interpretations which various writers have tended to make.

We may take Wylie's work first published in 1899 and again in 1903 as typical of the work of his predecessors, Tarbell and Shuttleworth. Wylie compared, age for age, the average height and weight curves of feeble-minded boys and girls in the Minnesota Institution for the Feeble-minded at Faribault with Gilbert's norms for Iowa school children and Roberts' table of height and weight of English school children.[31] The curves for the feeble-minded are slightly below and sometimes above the curves for English school children but are consistently below the curves for Iowa school children. Wylie does not hesitate to conclude, "The feeble-minded are subnormal in height and weight" (p. 6). Wylie must have possessed a mental blind spot inasmuch as he completely overlooked the fact that English school children (presumably normal in intelligence) were likewise subnormal in height and weight if Iowa school children were to be accepted as the standard for comparison. But why should Iowa school children be taken as the criterion group? Any one who has thought about the difficulty, if not the impossibility, of setting up universal standards or norms is aware of the necessity of establishing a multiplicity of norms each carefully defined in respect to age, sex, racial origin, nationality, social and economic status, etc. A norm or standard has significance for comparative studies only when so defined and so delimited. For this reason, height and weight curves for the feeble-minded cannot be properly interpreted unless they are compared directly with curves for normal children of the same age, sex, race, nationality, and social-economic status. To date, no investigator of this particular problem has complied with this elementary but essential requirement. Insistence upon rigorous control of these factors compels rejection of Wylie's conclusion, as at least unsubstantiated.

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[29] G. G. Tarbell, "On the Height, Weight, and Relative Growth of Normal and Feeble-minded Children," *Proc. of the Assoc. of Med. Officers of the Am. Inst. for Idiotic and Feeble-minded Persons,* 1876-86, pp. 188-189.

[30] G. E. Shuttleworth, "The Health and Development of Idiots Compared with Mentally Sound Children of the Same Age," *Proc. of the Assoc. of Med. Officers of the Am. Inst. for Idiotic and Feeble-minded Persons,* 1876-86, pp. 315-322.

Norsworthy, in 1906, brought out her monograph on the psychology of the feeble-minded.[32] She attempted to determine, among other things, whether the mental deficiency of idiots is accompanied by a corresponding deficiency in physique. Most writers up to that time had associated physical deficiency so closely with mental deficiency that they had come to look upon physical deficiency itself as being a sign or symptom of idiocy. Norsworthy summarized the consensus of opinion as follows: "On the whole, then, the tendency is to consider mental defectives as ill grown, poorly developed individuals" (p. 18). Norsworthy herself failed to find warrant for this. She obtained height and weight measurements of 157 mental defectives in the Schools for the Feeble-minded at Waverly, Massachusetts, at Lakeville, Connecticut, and in the special classes in one of the New York public schools. As a standard of comparison the Boas standards for height and the Bowditch standards for weight were used. The status of each defective individual relative to the norm for his age and sex was found by converting each measurement into a multiple of a standard measure of variability. Study of the detailed results justifies the conclusion, "The mental defects among idiots are by no means equaled by the bodily. In fact, in measurements of height and weight the defectives are indistinguishable from ordinary children" (p. 67). That Norsworthy was generalizing in terms of *individuals* is evident, since, by the use of the method of overlapping, she found the feeble-minded to be retarded physically *on the average* to a very slight and insignificant degree. Her results on this point show that 44 per cent. of the mentally deficient children exceed the median for ordinary children in weight and 45 per cent. of them exceed the norm in height. Failure of subsequent investigators to recognize the scientific merit inherent in Norsworthy's methodology and conclusions has served to perpetuate to the present day erroneous notions regarding the physical status of the feeble-minded.

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[31] A. R. T. Wylie, "Investigation Concerning the Height and Weight of Feeble-minded Children," *Jour. Psycho-Asthenics*, 1899, 4:47-57; also by same author, "Contribution to the Study of the Growth of the Feeble-minded in Height and Weight," *Jour. Psycho-Asthenics*, 1903, 8:1-7.

[32] Naomi Norsworthy, "The Psychology of Mentally Deficient Children," *Archiv. of Psychol.*, 1906, 1:1-111.

Goddard's data, published in 1912, are the most extensive on record being based on approximately 11,000 cases ranging in age from birth to 60 years from 19 American institutions for the feeble-minded.[33] The height and weight curves for some 6,000 males are reproduced in Figure 6. It is well to scrutinize institutional data such as we are dealing with in Figure 6, since factors of selection may be operative. For example, if the reader will disregard the height curves beyond age 13 by covering the right hand side of the figure it will be noted that the curves for normal, moron, and imbecile are practically indistinguishable. The curve for idiot, however, is distinctly lower, due no doubt to the presence of an undue proportion of pathological cases of feeble-mindedness such as Mongolians, Cretins, etc. Even in the case of the idiots there must be a great amount of overlapping, but since no data regarding variability are given we are at a loss to estimate the extent to which the idiots really differ from the normal in height. Beyond age 13 the curves tell an entirely different story. The curves fan out and show marked divergence for the various levels of ability represented. However, it is entirely possible that no difference in average height really exists between adult imbeciles, morons, and normals, the apparent difference beyond age 13 being due primarily to selective factors at work in institutional management or in the relations between the institution and society. For example, of the feeble-minded who return to civil life following such training as they may have received in the institution is it not reasonable to suppose that only the strongest (tallest and heaviest) would be deemed ready and fit to take up life's battles in an industrial society where many jobs require

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[33] H. H. Goddard, "The Height and Weight of Feeble-minded Children in American Institutions," *J. of Nerv. and Mental Diseases,* 1912, 39:217-235.

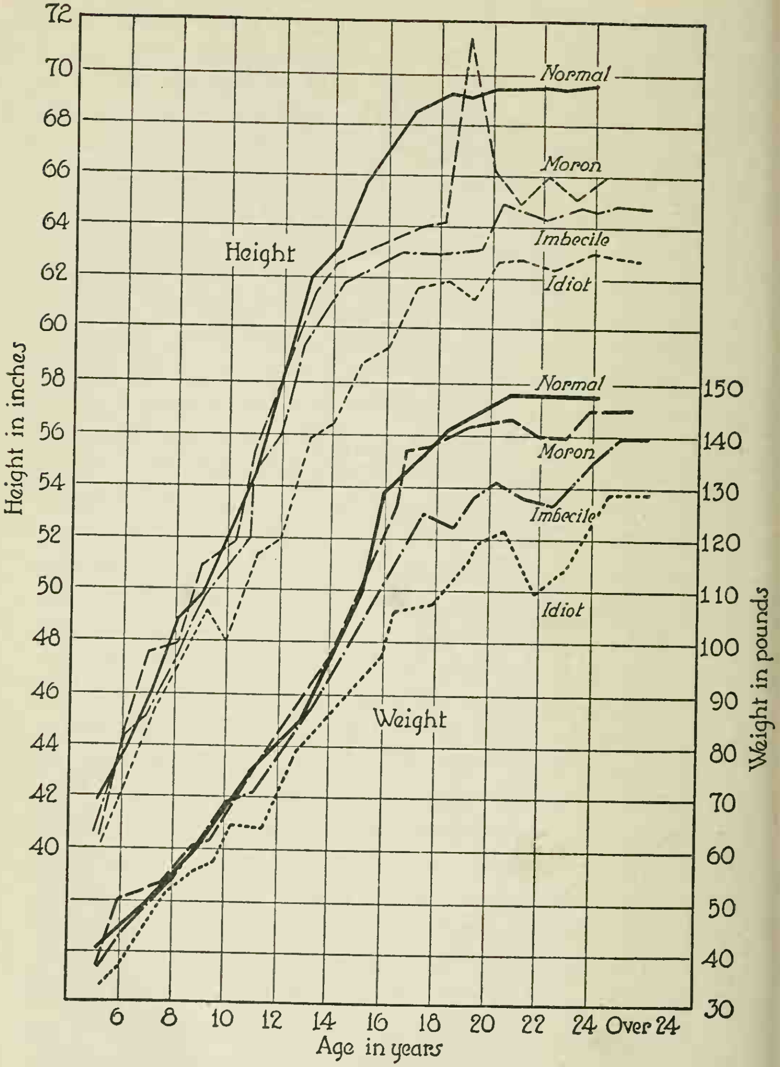

Fig. 6.

Curves showing the height and weight of feeble-minded inmates of American institutions, as compared with normals, age for age. (Reproduced by permission from Goddard.)

either a strong back, or nimble fingers rather than abstract intellect?

Scrutiny of the weight curves shows the same interesting phenomena, only in this case the identity of the weight curves for normal, moron, and imbecile continues on to age 16.

The presence of only a slight positive correlation between height and weight and intelligence among normal children would lead us to expect only a slight physical inferiority on the part of the feeble-minded. Apparently, such expectation is confirmed even by Goddard's data although his data have as the rule been uncritically accepted as demonstrating marked physical inferiority on the part of the feeble-minded.

In 1914, Mead published "Height and Weight of Children in Relation to General Intelligence." [34] In this study, children of normal intelligence and feeble-minded children (including apparently all varieties and types of feeble-mindedness) were compared with respect to height and weight. The curves show fairly marked average differences, and so to the author: "It seems a safe conclusion from the above data that not only is mental defect reflected on the average in the height and weight of children, but the more decided the defect the more checked the physical growth. This is more evident in height than weight" (p. 405). Contained in the article itself is an admission that the normal children were selected from an unusually favored community. This suggests a definite lack of comparability between the feeble-minded and the normal with respect to social-economic status. Were children of normal intelligence equated with feeble-minded children on the basis of social-economic status it is likely that the observed differences in height and weight would largely disappear. This selective

[34] C. D. Mead, "Height and Weight of Children in Relation to General Intelligence," *Ped. Sem.*, 1914, 21:394-406.

factor is undoubtedly greatly accentuated during the adolescent years. Physical norms for these years are based upon normal children retained in the upper grades and high school. The selective character of secondary education is such as to retain the brightest and most favored children (upper social-economic levels) during adolescence, hence it is little wonder that the most pronounced physical differences shown in Mead's study occurred during the adolescent years. This same point should be made with reference to Goddard's data as well, although in commenting upon that data we were content with merely mentioning the fact of selective retention of cases in feeble-minded institutions.

Doll's elaborate attempt to utilize anthropometry as an aid in the diagnosis of feeble-mindedness was derived largely from an initial belief in the physical inferiority of the feeble-minded, although he recognized upon completion of his research that their deficiency in physical measurements (height and weight) is much less marked than their deficiency in such psycho-physical traits as strength of grip and vital capacity.[35] In regard to deficiency in these so-called psycho-physical characteristics it has been pointed out by Pintner that the psycho-physical tests constitute in themselves a crude sort of intelligence test insofar as for their performance there is required a desire to excel and an ability to understand and follow directions.

After a survey of previous literature Doll states, "With such concurrence of opinion it may seem unnecessary to offer further evidence. But as yet there has been no single study of the feeble-minded showing the specific relations of these several physical and psycho-physical measurements to each other, or to mental defect accurately rated in terms of intellectual levels" (p. 7).

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[35] E. A. Doll, *Anthropometry as an Aid to Mental Diagnosis* (Pub. by the Training School, Vineland, New Jersey, February, 1916), pp. 1-91.

Each physical and psycho-physical measurement was converted into a percentile score by reference to Smedley's age norms based on Chicago public school children. In this way it was hoped to eliminate differences due to chronological age and thus make all measurements for all subjects directly comparable.

He reports the following correlations "corrected for irrelevancy of chronological age":

r between standing height and mental age .... + .39 (N = 140 girls)
r between standing height and mental age .... + .31 (N = 333 boys)
r between sitting height and mental age .... + .47 (N = 140 girls)
r between sitting height and mental age .... + .41 (N = 333 boys)
r between weight and mental age .... + .34 (N = 140 girls)
r between weight and mental age .... + .23 (N = 333 boys)

Apparently there is a definite positive correlation between these physical measures and mental age, ranging from + .23 to + .47. But these must not be accepted at face value because genetically there is a difference between simple feeble-mindedness and pathological varieties of feeble-mindedness (confined for the most part to the lower mental ages and, generally speaking, non-hereditary). We must inquire, then, into the question whether this relationship is general for all levels of mental ability or whether it is produced chiefly at the level of the lower mental ages where the presence of Mongolians, Cretins, etc., may be solely responsible for the positive correlation.

Table 7 gives us the facts permitting a more accurate appraisal of Doll's reported correlations.

A glance at Table 7 shows that the average percentiles for both boys and girls approximate the normal for all mental ages beyond M.A. 5 (a variation of 10 percentile points from the median is an insignificant variation). There seems to be a sharp dividing line between M.A. 5 and M.A. 6 in this respect, and my interpretation of this apparently strange division is that below M.A. 6 there is present

TABLE 7

Average of Physical Measurements for Feeble-minded Boys and Girls Arranged According to Mental Age. (After Doll, *Anthropometry as an Aid in Mental Diagnosis,* p. 44.) Note: The unit of measurement is the percentile with 50 representing the median or average for normal children.

	BOYS		GIRLS	
Mental Age	*Number*	*Average of Ht. & Wt.*	*Number*	*Average of Ht. & Wt.*
1	18	20.5	9	15.3
2	48	30.6	29	24.1
3	32	30.2	15	31.7
4	26	32.7	10	17.5
5	29	21.1	15	30.9
6	46	37.4	13	47.3
7	41	40.1	23	47.0
8	46	44.0	9	44.7
9	27	54.7	12	45.8
10	20	45.7	5	55.4
11	3	70.0	1	69.0

an undue proportion of accidental, non-hereditary and pathological varieties of idiocy and imbecility which are responsible for the markedly lower physical averages.[36] At any rate the correlation between these physical measures and mental age for M.A. levels 6 to 11 (a range which includes 246 cases or 51 per cent. of all the cases) is only + .16 ± .04, whereas the correlation between these physical measures and mental age for M.A.'s 1 to 5 inclusive is still less, i.e., + .02 ± .04. The scattergram for all cases as plotted from Tables 3 and 4 in Doll's monograph is shown in Table 8.

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[36] This interpretation might be challenged by those familiar with Doll's study because he stated, on p. 75, with reference to selection of subjects, "They represent all grades and clinical types of feeble-mindedness *except those having significant physical defects.*" (Italics not in original.) But this statement cannot be reconciled with measurement data for 22 Mongolians, given on p. 67. Regarding these data, he states, "Table 18 was constructed from *data on 22 Mongolians included in the general tables.* . . . It is important to note that Mongolians are characteristically short and heavy, and also long-waisted." (Italics not in original.) This very table clinches our argument, since these Mongolians are shown not only to be undersized but also to have low mental ages. Twenty-one of them have mental ages below 6. The one exception has a mental age of 6.

TABLE 8

Scatter Table Showing Relation Between Physical Average (Average of height, sitting height, and weight measurements expressed as percentiles) and Mental Age for 477 Feeble-minded Inmates at Vineland, N. J. (Table constructed from original data given by Doll in Tables 3 and 4 of *Anthropometry as an Aid in Mental Diagnosis*.) Correlation = + .31 ± .03.

Physical Average (Percentile)	*Mental Age*											
	1	2	3	4	5	6	7	8	9	10	11	*Total*
91–100....	..	4	1	1	..	2	4	3	3	1	1	20
81–90	1	..	3	3	1	5	4	3	2	2	1	25
71–80	1	2	3	..	..	3	3	1	5	2	..	20
61–70	..	5	2	..	3	4	6	7	6	..	1	38
51–60	..	4	3	3	..	9	7	9	5	2	..	42
41–50	4	6	7	5	4	5	7	6	2	5	..	51
31–40	..	9	..	1	8	6	5	6	7	1	..	43
21–30	2	13	3	3	8	6	13	10	4	2	1	65
11–20	5	9	9	7	8	6	8	5	4	5	..	66
1–10	14	25	16	13	12	13	7	5	1	1	..	107
Total...	27	77	47	36	44	59	64	55	39	25	4	477

The correlation is + .31 which corresponds roughly to the correlations reported by Doll for the separate physical measures and mental age for the two sexes. Not only do these correlations emphasize the fact that cases in the lowest mental ages are almost entirely responsible for the general correlation of + .31 but also inspection of the scattergram as given in Table 8 shows that the feeble-minded with average physical percentiles from 1 to 10 are concentrated in the lowest mental ages.

This belief in the existence of a striking concordance between mental deficiency and physical deficiency continues to color interpretations of data which, if critically scrutinized, fail of substantiation. Witness the research report of Dr. N. A. Dayton, director of the Division of Research of the Massachusetts Department of Mental Diseases, who in 1928 presented an analysis of the height and weight measurements of 3,553 retarded public school children in the State of Massachusetts.[37] The I.Q.'s of these children were computed from Stanford-Binet tests and the relation to height and weight measurements worked out. The final conclusion is that, "In this sample, degree of physical deficiency is *closely* associated with degree of mental deficiency." (Italics added.)

In view of the positiveness of such a conclusion it is necessary to review the data in some detail. Seventy-two per cent. of these children were diagnosed as "feeble-minded." Eighty-nine per cent. of the I.Q.'s were below 80. Since the bulk of the children were between the ages of 8 and 12, an age range where the Stanford-Binet is most adequately standardized, there is reason to believe that the obtained I.Q.'s were accurately determined. Relative stature and relative weight were determined by comparing the height and weight measurements with norms provided by a table derived from Holt's *Diseases of Infancy and Childhood* and from Whipple's *Manual of Physical and Mental Tests*. Those deviating from the height norms for a given age by more than one inch were designated as "over-average" or "under-average." Variation within the limits of one inch constituted the "average" category. Those deviating from the weight norms for a given age by more than five pounds were labeled "over-average" or "under-average." Those weighing within five pounds of the norm, plus or minus, were regarded as "average." The mean I.Q.'s were then computed for each of these classified groups of children. These data are shown in Table 9. The differences shown are statistically significant, but that does not mean they are large. They are, in fact, slight. The amount of individual variation within each classified height or weight group is such as to warrant the prophecy that a coefficient of correlation computed between I.Q. and relative height or between I.Q. and relative weight would be very low indeed. It is unfortunate that a correlation analysis was not attempted.

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[37] Dayton, N. A., "Height, Weight, and Intelligence Relationships in 3,553 Retarded School Children," *New England J. Med.*, 1928, 199, pp. 934-938.

TABLE 9

Mean I.Q. for Retarded Children Classified as Over-average, Average, and Under-average in Height and in Weight. (Based on data presented by N. A. Dayton, M.D., *New England J. Med.*, 1928, 199, pp. 934-938.)

	Mean I.Q.	*S.D. of Mean*
A. *Height*		
Over-average	68.5	.34
Average	66.3	.34
Under-average	61.5	.34
B. *Weight*		
Over-average	68.4	.37
Average	67.1	.41
Under-average	62.8	.33

We may gain a clearer notion of the absence of any very close correlation between intelligence and stature or weight by showing the percentage of these retarded children coming within each physical category. These percentages are shown in Table 10. If we regard over-average height children as tall and under-average height children as short it is clear that these retarded children are not characterized by undue shortness of stature. If physical deficiency in height is closely associated with mental deficiency, as Dr. Dayton states, how can we account for the fact that almost one third of these mentally retarded children may be regarded as tall when judged by norms provided by children of normal intelligence? In regard to weight, there is some evidence, to be sure, which indicates that there is a slightly larger proportion of these retarded children who are under weight. Even so, 28.5 per cent. of them are definitely over weight. All in all, we may regard these data as failing to support the commonly accepted generalization regarding an intimate association between physical deficiency and mental retardation.

TABLE 10

Percentage of 3,553 Retarded Public School Children Classified as Over-average, Average, or Under-average in Height and in Weight. (Based on data presented by N. A. Dayton, M.D., *New England J. Med.*, 1928, 199, pp. 934-938.)

Classification	*Height Per Cent*	*Weight Per Cent*
Over-average	31.5	28.5
Average	34.5	25.0
Under-average	32.5	40.0
Unknown	1.5	6.5
Total	100.0	100.0

Another recent study is that reported by Wheeler comparing physical measurements of dull children (I.Q.'s below 90) with normal children (I.Q.'s between 90 and 110).[38]

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[38] L. R. Wheeler, "A Comparative Study of the Physical Growth of Dull Children," *J. of Educ. Rev.*, 1929, 20:273-282.

These data, derived from the carefully conducted Harvard Growth Study, are especially significant since the factor of racial descent was carefully controlled (restriction to children of North European descent) and the measurements of intelligence were likewise made with unusual care and thoroughness (I.Q.'s determined by Dearborn Group Intelligence tests given to the same children for six consecutive years). In all, 154 mentally dull boys and 119 mentally dull girls ranging in age from six to twelve inclusive, were studied. The comparison of dull and normal children with respect to standing height, sternal height, sitting height, leg length, trunk length, iliac width, and weight shows a consistent though slight difference, on the average, at each age from six to eleven in favor of normal children. In 42 such comparisons the difference divided by the probable error of the difference $\left(\frac{D}{PE_{diff}}\right)$ is greater than 4.00 just eight times, hence the differences for the most part are lacking in technically stated statistical significance. However, this lack of statistical significance is due to the small number of cases in each age group. The trend itself is so consistent for all comparisons at all ages that we are justified in concluding that a slight difference exists. But Wheeler seems to be magnifying the amount of the differences found and to be overemphasizing the possible practical significance of such differences when he offers the following conclusions:

> "The results of this study and previous investigations indicate that the dull child is not only handicapped mentally, but he is penalized in physical growth. Since growth is not dependent on any one factor, but on a multiple of different influences, the school should consider physical growth as a factor in the classification, instruction, and promotion, especially when the child deviates widely, above or below the normal growth for his age" (p. 281).

Wheeler has undoubtedly demonstrated slight physical differences between mentally dull and normal *children in the mass,* a finding which throws little or no light upon the functional relationship between the variables of physique and intellect as found *in individuals.* We may seem to be unduly laboring this point, but observe that Wheeler has recommended differential *individual* treatment on the basis of a general existential relationship.

Altogether the evidence, when analytically evaluated, would seem to be negative as regards marked physical inferiority of the feeble-minded, barring, of course, such pathological varieties as Mongolians and Cretins in whom there is a conspicuous stunting of growth. We may conclude, then, that feeble-minded and mentally dull children are slightly inferior physically to normal children.

c. *Gifted or precocious children.*—In view of the evidence already before us we should expect that gifted children would be slightly superior, on the average, in height and weight to normal children. B. T. Baldwin contributed one chapter to Terman's *Mental and Physical Traits of a Thousand Gifted Children* giving the anthropometric measurements.[39] The average height and the average weight, age by age, is given in a table on p. 145 for the gifted boys and for the gifted girls as well as the same averages for various selected groups of normal children. It is apparent that the gifted children, as a group, are slightly superior to samplings of normal children. Perhaps an even better comparison is afforded by reference to the classification of these gifted boys and girls as tall, medium, or short according to the new Baldwin-Wood tables for tall, medium, and short American children, based upon records from 124,000 well developed

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[39] L. M. Terman, *et al.*, "Mental and Physical Traits of a Thousand Gifted Children." *Genetic Studies of Genius* (vol. I, Stanford University Press, 1925), ch. VII, pp. 135-171.

American-born children measured without clothing. The figures given are as follows:

Height Classification	*Gifted Boys*	*Gifted Girls*
Tall	44	45
Medium	233	208
Short	35	29
Total	312	282

The above classification does not reveal any marked tendency for gifted children to excel normal children in height. There is a *tendency* for gifted children to be taller, but it is a tendency revealed in averages only. The great majority of gifted children are like normal children in being of medium stature.

Correlations reported bear out the foregoing interpretation as may be seen from Table 11.

Table 11

Coefficients of Correlation Between Mental Age and Height and Weight of 397 Gifted Children. (After Terman, *Genetic Studies of Genius*, vol. I, p. 168.)

Chronological Age	HEIGHT AND MENTAL AGE				WEIGHT AND MENTAL AGE			
	Boys		*Girls*		*Boys*		*Girls*	
	No. of Cases	r	No. of Cases	r	No. of Cases	r	No. of Cases	r
10	35	.16±.11	42	.15±.10	35	.44±.09	42	.16±.10
11	68	.15±.08	48	.34±.09	67	.04±.08	48	.14±.10
12	63	.10±.08	45	.08±.10	61	—.09±.09	45	—.06±.10
13	50	.33±.09	46	.04±.10	50	.31±.09	46	—.20±.10

Although the P.E.'s of the coefficients are so large as to invalidate the significance of any of the individual coefficients, yet taking them all together and striking an average we may be fairly certain that a slight positive correlation does exist.

Hollingworth in her study of gifted children adds confirmatory evidence.[40]

> "To form three comparative groups, each gifted child was matched with a child testing between 90 and 110 I.Q. and with another testing below 65 I.Q. keeping age, race, and sex as the bases of matching and paying no attention whatever to size. Thus differences in size due to age, race, and sex were eliminated."

The results are presented in Table 12.

TABLE 12

Distribution of Height (in inches) Among Three Groups of Children, 9-11 Years Old,—Age, Race, and Sex Being Constant in the Three Groups. (After Hollingworth, *Gifted Children*, p. 80.)

Inches	*Group A. I.Q. above 135 (Median I.Q., 151)*	*Group B. I.Q. 90–110 (Median I.Q., 100)*	*Group C. I.Q. below 65 (Median I.Q., 43)*
55–59	12	2	1
50–54	30	30	18
45–49	3	13	23
40–44	0	0	3
Total	45	45	45

The median height of the gifted group is 52.9 inches, as compared with a median of 51.2 inches for the children of average intelligence, and of 49.6 inches for the very dull or feeble-minded group.

A similar superiority for the same gifted group in weight is shown by Hollingworth using exactly the same method of procedure.

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[40] L. S. Hollingworth, *Gifted Children* (The Macmillan Company, New York, 1926), ch. IV, "Physique and Movement," pp. 78-115.

The cautiousness with which Hollingworth interprets her data is best shown by quotation: "That the demonstrated relationship between superiority of mind and superiority of body is causal, can not be inferred. There is nothing in our data to suggest that the superior children are bright *because* they are tall and heavy nor that they are tall and heavy *because* they are bright. We can only say that mentally gifted children, as a group, are large and strong at the ages studied, in so far as we have measured them." [41]

3. Studies of Adults.

Studies employing adult subjects can not be regarded as favorably as those utilizing children, since for the most part only college students have been measured. College students do not represent a random sampling of the adult population. Neither do they constitute a random sampling even of their own age, since they are a highly selected group both mentally and socially. This being so, we should expect to find even lower correlations between intelligence and the physical attributes of height and weight. For the sake of completeness, the available evidence is reviewed here.

Lee, Lowenz, and Pearson studied "honor" men and "pass" men at Cambridge, using scholastic standing as a criterion of intellect. They found r between weight and intelligence to be +.05.[42] They concluded that the honor men could not be differentiated as a physical class nor could one predict, with even a moderate degree of probability, an individual's degree of intelligence from knowledge of that individual's physical status. This study is interesting in the main because it supplies a definite quantitative contradiction to the classic Galtonion view referred to at the beginning of this chapter. In all fairness to Galton, it should be said that he repudiated his earlier position by stating, in 1891, "The experience gained by the measurement of about 2,000 students at Cambridge conclusively proves that success in literary examinations is in no manner connected with stature, weight, strength, or breathing capacity, and but slightly with keenness of eyesight" (p. 55).[43]

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[41] L. S. Hollingworth and G. A. Taylor, "Studies of Physical Condition and Growth," *Twenty-third Yearbook of the National Society for the Study of Education* (Public School Publishing Co., Bloomington, Ill., 1924), 1:221-237.

[42] A. Lee, M. A. Lowenz, and Karl Pearson, "On the Correlation of Mental and Physical Characters in Man," Proceedings of the Royal Society, 1903-1904, pp. 106-114.

Sommerville's study of the relation between a large number of physical measurements and intelligence of 100 college students measured by the Thorndike three-hour intelligence test was conducted at Columbia and in a sense may be looked upon as a continuation of the earlier work of Cattell and Wissler at that same institution.[44] The correlation between intelligence and height was found to be + .16; between intelligence and sitting height + .13; between intelligence and weight + .10; and between intelligence and chest girth + .01. The P.E.'s of these coefficients of correlation are in the neighborhood of ± .07.

Brooks' study covering five groups of subjects from the third year in high school, normal school, and the freshman year in college may be regarded as filling in the gap between childhood and maturity.[45] He used well standardized intelligence tests. Chronological age was controlled either by appropriate age grouping or by partial correlation analysis. The general trend of the correlations may be summarized as follows: 17 correlations between height and intelligence ranged from — .08 to + .26 with a median value of + .008; 17 correlations between weight and intelligence ranged from — .10 to + .31 with a median value of + .007. These results point toward a zero correlation between height or weight and intelligence during late adolescence for subjects continuing their education.

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[43] Francis Galton, "Useful Anthropometry," Proceedings of the Am. Assoc. for the Advancement of Physical Education, Boston, April 3 and 4, 1891, pp. 51-58.

[44] Richard C. Sommerville, "Physical, Motor, and Sensory Traits," *Arch. of Psychol.*, 1924, No. 75.

[45] F. D. Brooks, "The Organization of Mental and Physical Traits During Adolescence," *J. of Applied Psychol.*, 1928, 12:228-242.

These studies merely add to the cumulative evidence assembled in the preceding sections tending to demonstrate absence of marked correlation between physical size and intellect.

4. The Possible Influence of Social Status.

It is possible that differences in social status may be responsible for the slight positive correlations disclosed in preceding sections of this chapter. This hypothesis seems tenable in view of abundant evidence indicating that both physical characters and mental ability are positively correlated with social status.

According to this view, the relationships might be explained as follows. Higher social classes are able to provide better prenatal and postnatal care for offspring, resulting in healthier and physically superior infants. Better hygienic living conditions, greater variety and better balance in diets, and abundant food provided throughout the period of childhood would perpetuate and increase physical advantages gained in infancy. This superior nurture, if also responsible for the mental superiority of children belonging to the favored social classes, would constitute the causal factor. Even if the potency of this superior nurture were confined solely to physical growth, whereas nature (biological heredity) were responsible for the mental superiority of upperclass children, the hypothesis would still be effective, although social status could no longer be looked upon as a single causative factor. In this latter case, nature and nurture would combine to produce association but not functional relationship between physique and intellect.

A crucial test of the above theory would be provided by a demonstration that the slight positive correlation between physique and intellect which has generally been found disappears when social status is held constant.

Sorokin, in a brilliant contribution to objective sociology, summarizes a large number of research studies showing that bodily differences do exist between the populations of higher social strata and of lower social strata.[46] Along with this evidence he cites additional data confirming the generalization that there is a definite relation, on the basis of averages, between social standing, intelligence, and physical size. The reader interested in the detailed evidence is referred to Sorokin's comprehensive summary of the available literature.[47]

[46] P. Sorokin, *Social Mobility* (Harper and Bros., New York, 1927).

[47] Sorokin's summary is a good illustration from the sociological field of the frequent use of *averages* unaccompanied by measures of variability or coefficients of correlation. The several authors quoted by him present data in terms of averages and average differences only, hence the unwary reader is apt to magnify the extent to which social status is really correlated with various physical traits. If correlation coefficients (Pearson Product Moment, Contingency Coefficients, Biserial *r*'s, etc.), had been computed in the various investigations cited, they would most certainly have been low. Sorokin himself seems to err in the direction of exaggeration when he concludes, "On the bases of the above data, it is safe to say that *there is a tangible correlation between high stature and high social class, on the one hand; between a low stature and low social class, on the other hand, providing social classes of a given society are taken into consideration.*" (P. 222; italics in original.) If the misleading character of the method of *correlation of averages* had been explicitly set forth, the uncritical reader would not be so likely to misinterpret the

Pearson in 1906 pointed out in vigorous language that the hypothesis which we are here considering, must be kept in mind in determining the nature and significance of the relationship between physical characters and intellect, when the hypothetical influence of the social status factor has been excluded by refinements of analysis. He stated, "Nurture, exercise, and nourishment—shortly environment and class-district or local race, influence extensively the anthropometric measurements. We cannot compare pauper imbeciles or hospital post-mortem results with middle class students and professors. We cannot measure agricultural laborers and men of science and point triumphantly to great differences in head volumes as marking widely separate intellectual grades"[48] (p. 122). In the light of this statement, it behooves us to determine whether or not the holding of social status constant tends to dissipate the observed relationship.

The fact that slight though sensible correlation appears to exist between physical size and intellect not only for random samplings of childhood populations but also within

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generalization. In all fairness, however, it must be pointed out that Sorokin does recognize the existence of overlapping (variability) and specifically calls attention to this phase of the problem. Nevertheless, the tremendous amount of overlapping which would accompany slight though sensible correlation of the variables social status and stature as found in individuals is not emphasized as it should be to prevent misinterpretation by the statistically untrained reader. As an example of Sorokin's tendency to magnify the amount of relationship between social status and bodily traits take the statement, made in commenting on the average differences in head size between officers and privates, between executives and employees, and between professors and students, given by Röse (the average differences are slight and are unaccompanied by measures of variability), "The figures exhibit a striking correlation between social position of a group and an average head size of its members" (p. 228).

[48] Karl Pearson, "Relationship of Intelligence to Size and Shape of the Head and other Mental and Physical Characters," *Biometrika*, 1906, 5:105-146.

more homogeneous groups such as the feeble-minded on the one hand and the gifted on the other hand strongly suggests that social status is not the primary cause of such correlation. This suggestion arises in view of the fact that some four-fifths of the gifted children are recruited from the upper social classes, whereas a large proportion of the feeble-minded are recruited from the lower social classes. This means that the correlation between physique and intellect remains even though mentally and socially homogeneous children are studied separately. It is important, too, that this correlation not only appears but also seems to be of about the same magnitude (slight though this may be) as that found for samplings of children which are quite heterogeneous in these respects. This point seems to be clinched by the evidence which Porter presented showing that the relationship between average weight and grade location for constant chronological age remains as definite when children whose fathers are working within a single trade or profession are studied as when children coming from all levels of society are studied.[49] In the next chapter additional evidence is cited from MacDonald's work.

In the present state of our knowledge, it would seem that social status cannot be invoked as a causal factor producing the physical-mental correlations. All of the data reported in this chapter seem to be in harmony in disclosing the existence of a slight though definitely positive correlation between physical development as indicated by height and weight and mental development, such correlation being present irrespective of the social status factor. This generalization seems to hold for feeble-minded, dull, normal, and gifted children alike.

[49] W. T. Porter, "The Growth of St. Louis School Children," Trans. of the St. Louis Academy of Science, 1895, 11:335-338.

5. Significance of the Findings.

It is obvious that such slight correlation as seems to exist between intellect and height or weight precludes the possibility of using height or weight as a basis for predicting probable intelligence in any given individual case. Although a slight relationship is revealed in terms of averages for the *mass*, the situation with reference to the *individual* amounts to a condition of almost complete independence. In other words, individuals representing the extreme limits of variability in physical size (barring, of course, pathological conditions such as cretinism) may be expected to exhibit any degree of intelligence from high to low.

To illustrate this point, the writer decided to select from among the present student population at the University of Minnesota one of the tallest men and one of the shortest men on the campus. These two students were selected on the basis of size alone without knowledge either of their scholastic ability, mental test measurements, or physical examination records. It so happens that when their entrance records were obtained both were found to be mentally superior to the average student. The available data regarding these two students at time of entrance to the University as freshmen are shown on the next page.

The comparative data speak for themselves. Both students are alike in all essential respects except height and weight. Apparently, the difference of approximately 20 inches in height means little or nothing so far as physical condition, mentality, or economic or social status is concerned.

The precarious basis for individual predictions afforded by such slight correlations as have been cited is also present even when we attempt the far easier task of group predictions. We may illustrate this point by comparing the mental

	Mr. A.	*Mr. B.*
Age at time of entrance to University	19	17
Physical Data		
Height	77 inches	57¼ inches
Weight	168 pounds	111¾ pounds
Muscular development	Good	Fair
Nourishment	Thin	Average
Muscle tone	Good	Flabby
Thyroid gland	Normal	Normal
General health	Good	Good
History of diseases	Influenza, measles, mumps, whooping cough	Influenza, measles, mumps, chickenpox
Mental and Social Data		
College Ability Tests, Raw Score	323 points	284 points
College Ability Tests, Percentile Score	91 %ile	75 %ile
Vocabulary "A" Test, Raw Score	106 points	96 points
Vocabulary "B" Test, Raw Score	100 points	92 points
High School Attended	Suburb of Minneapolis	Suburb of St. Paul
Religion	Protestant	Protestant
Economic status	Partially self-supporting	Partially self-supporting

and physical status of students at Yale University and at the University of Minnesota. Jackson reports as follows: The average height of Yale men is 1724 mm. and their average weight is 63.0 kg., whereas the average height of Minnesota men is 1745 mm. and their average weight is 64.2 kg. Both groups are approximately the same age (Yale ave. age 20.3 years; Minnesota ave. age 20.1.) [50] However, the physical superiority of Minnesota men is not accompanied by a similar superiority in mentality. The median score of Yale freshmen on the Army Alpha Intelligence Test was reported by Anderson as being 159.5,[51] whereas the median score of University of Minnesota freshmen was reported as being 129 on the same test.[52] Approximately 89 per cent. of the Yale freshmen exceeded the median Minnesota student. Only 11 per cent. of the Yale freshmen made a score as low as or lower than the median Minnesota freshman. This mental superiority of the Yale students is emphasized when we realize that their median score was actually 2.5 points higher than the median Alpha score made by graduate students at Ohio State University! These data definitely establish the success of Yale's selective admission plan in securing mentally superior freshmen. A state university, of course, in the absence of a selective admission policy, must provide an educational program adapted to the needs of a mentally less gifted group of students. But Yale's policy definitely fails to secure physical superiority as well. We would emphasize the importance of this comparative evidence in demonstrating the almost complete independent variability of mental and physical traits. The two variables are so slightly related that selective factors may easily operate to produce two groups contrasting mentally which differ physically to a significant extent in the reverse direction.

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[50] C. M. Jackson, *The Measurement of Man*, Part II, "Normal and Abnormal Human Types" (Univ. of Minn. Press, 1930), pp. 79-113.

[51] J. E. Anderson, "Intelligence Tests of Yale Freshmen," *School and Society*, 1920, 11:417-420.

[52] L. M. Terman, "Intelligence Tests in Colleges and Universities," *School and Society*, 1921, 13:481-494.

The absence of any close correlation between physical size and intellect suggests rather strongly that the glands of internal secretion which control growth do not afford a common factor affecting physical growth and mental growth alike and to the same extent. It may be true, of course, that growth-controlling glandular secretions do so operate but that the scope of such single control is limited merely to a minor rôle in the unfoldment of hereditary potentialities for physical and mental development, such hereditary factors being numerous and independently variable. Davenport has shown clearly, so far as physical development is concerned, that stature is an hereditary trait, tall parents of tall stock give rise to tall offspring, short parents of short stock give rise to short offspring, etc.[53] However, stature is not inherited as a "unit character," multiple hereditary determiners being involved which tend toward independent variability among the various segments of the body contributing to total stature. One might well be justified in assuming that if stature itself be a resultant of many independently variable determiners then there is no genetic reason for the antecedent expectation that the determiners for physical segments of the body should be the same as those providing the potentialities for mental growth. As a matter of fact, there is a growing mass of evidence that the most potent factor responsible for the range of individual differences in intellect is biological heredity. But this book is not concerned with this specialized topic.

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[53] C. B. Davenport, "Inheritance of Stature," *Genetics*, 1917, 2:313-389. The relation between glandular control and inheritance of stature is commented upon by Davenport as follows: "Assuming that excessively tall stature is the result of excessive activity of the pituitary gland, then it seems necessary to conclude that peculiarities in the functioning of endocrine glands are influenced by genetic factors—have an inheritable basis" (p. 385).

Finally, it is apparent that the pedagogical and educational significance of physical size is far less than early students and even some of our contemporary writers have assumed. Indeed, there is reason to affirm that physical measurements of school children should concern the school administrator and teacher in connection with the program of physical education and participation in extracurricular physical activities but should concern him academically only in so far as physical size is a factor to be reckoned with in determining the size of desks and seats to be installed in the school room!

Chapter III

CRANIAL MEASUREMENTS AND INTELLIGENCE

1. Brief Historical Introduction.

THE belief that there is an intimate relationship between the intelligence of a man and the size and shape of his head has been, and perhaps still is, as widespread as it is ancient. To review the history of this belief adequately would take us far afield, for we should be compelled to trace its ramifications through phrenology, physiognomy, paleontology, anatomy, craniometry, anthropology, neurology, psychology, and sociology. We shall mention, therefore, only some of the more obvious factors responsible for the origin of the belief and its survival as an arresting scientific problem.

Certain inferences from the theory of evolution and especially from the study of the evolution of man directed attention to the probable significance of head size as an indicator of intelligence. Comparative studies of skull capacity in the apes, prehistoric man, primitive races, and civilized man revealed in general a correlation between head volume and cultural evolution. The following measurements derived from data reported by Hankins and by Porteus and Babcock, indicate the trend in unmistakable fashion: [1]

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[1] F. H. Hankins, *The Racial Basis of Civilization* (Alfred A. Knopf, New York, 1926), p. 309; also: S. D. Porteus and M. E. Babcock, *Temperament and Race* (Richard G. Badger, The Gorham Press, Boston, 1926), p. 146.

Anthropoid apes	621 cc.
Pithecanthropus erectus (estimated)	855 cc.
Veddas	1277 cc.
Andaman Islanders (average for males)	1300 cc.
Australian aborigines	1340 cc.
Negroes	1350 cc.
Ainus (in Northern Japan)	1462 cc.
Europeans	1490 cc.
Parisians	1555 cc.

Another source of the inference that there is a relation between head size and intelligence is the microcephalic idiot. The tendency to connect idiocy with microcephaly and by implication exclusively, with microcephaly, is illustrated by Fowler in his defense of the phrenological doctrine of head size as a causal determinant of intelligence.[2] He published an outline picture of an unusually small head labeled "idiot." The uncritical reader easily gains the notion that an exces-

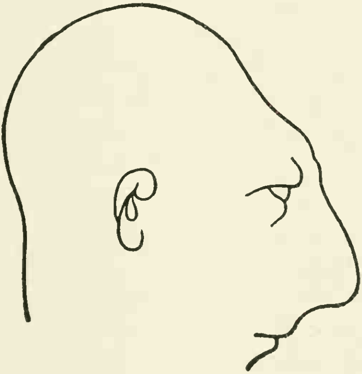

Fig. 7.
Head of idiot. (From Fowler.)

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[2] O. S. Fowler, *Human Science or Phrenology* (Nat. Publishing Co., Phila., 1873), p. 174.

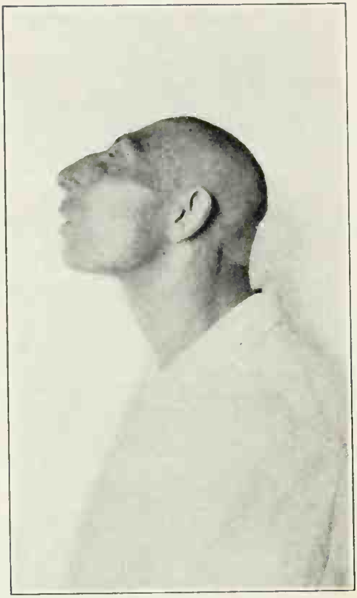
sively small head characterizes idiots in general. However, from the general shape and form of this head we readily recognize it as representative of only a single pathological or clinical variety of idiot, namely, microcephalic idiocy. Fowler's illustration is reproduced as Figure 7. The two accompanying photographs, showing front view and profile view of a low-grade microcephalic imbecile, exhibit the same defect and are inserted here for purposes of comparison. This individual had two microcephalic brothers, one with a mental age of three, the other of four years.

Quotations from Dr. Gall, founder of Phrenology, emphasize the extent to which pathological microcephalic idiots influenced the development of the doctrine in question. Thus Gall, at the beginning of the nineteenth century, wrote: "The heads of idiots, unless otherwise diseased, are characterized by deformity or smallness; the heads of eminent men, by their magnitude." Or again, "There is undoubtedly a very close connection between the absolute size of the brain and the intellectual powers and functions of the mind. This is evident from the remarkable smallness of the brain in cases of congenital idiocism, few much exceeding in weight that of a new-born child." Fowler generalizes without restraint: "The brain increases and decreases as the mental capacities increase and decrease. . . . Most idiots have small heads. . . . Great men have great brains. . . . The author found Webster's massive head to measure over twenty-four and one half inches, Clay's twenty-three and a half plus, and Van Buren's equally large." [3]

It is easy to see how the existence of microcephalic idiots could encourage belief in head size as symptomatic of intellectual development. The formula would run somewhat as follows: Small head = small skull; small skull = small brain; small brain = small intellect; therefore, small head =

[3] O. S. Fowler, *op. cit.*, pp. 169-170.

Front view of low-grade microcephalic imbecile, chronological age 25, mental age 3. Reproduced by permission from photograph supplied by Dr. Charles S. Bernstein



Profile view of same microcephalic imbecile. Reproduced by permission from photograph supplied by Dr. Charles S. Bernstein

small intellect. This formula, of course, could be and was made to work in the opposite direction as well.

While phrenologists seized upon the microcephalic idiot to bolster up their theories regarding head size they neglected an equally dramatic but unfortunately negative case. They ignored hydrocephaly, a condition in which the patient has an enormous head accompanied by limited mental development. Of course, by refinement of the argument a claim can be made that it is legitimate to ignore hydrocephaly since the condition does not imply the presence of a large brain. It is due, rather, to excessive production of cerebrospinal fluid within the ventricles of the brain with consequent pressure upon skull bones forcing them apart and upon brain tissue thinning and gradually destroying the nerve cells. See illustration facing p. 106 for the typical head size and shape of the hydrocephalic idiot.

The cited kinds of reasoning are by no means confined to advocates of phrenology. Even persons who definitely condemn phrenology and physiognomy as pseudo-science, proceed to devise a theoretical basis for cephalometry as an indirect method of measuring intelligence.[4] After describing the neural elements in the brain, Porteus and Babcock state:

> "All of these nerve processes, each insulated with a sheath of myelin, must be packed into the white matter of the brain so that the failure of development of any considerable number of these in any area of the brain is reflected in a diminution of brain size. . . . Hence as the developing intelligence requires a larger brain it seems only natural to suppose that there should be an intimate association between the size of the brain and the amount of the intelligence" (p. 138).

Along with this thesis is the further assumption that cranial measurements of the living head will afford a fairly adequate though indirect basis for assessing brain size and intellect.

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[4] S. D. Porteus and M. E. Babcock, *loc. cit.*

2. Quantitative Studies on Head Size

The first quantitative data on this subject were derived from cranial measurements of 1095 Cambridge University students by Dr. J. Venn. Sir Francis Galton, in 1888, published a summary of these data together with a brief discussion of their scientific significance.[5] Galton assumed that the size of the brain is directly proportional to the cubic content of the skull and that the latter is adequately revealed by the product of three outside dimensions of the living head (length × breadth × height). Table 13 presents the summarized data. Galton interprets these data as showing a difference of 5 per cent. in head volume between the high

TABLE 13

Average Head Size of 1095 Cambridge University Students Classified by Age and Scholastic Attainment. (After Galton, 1888.)

	HIGH HONOR MEN		REMAINING HONOR MEN		"POLL" MEN	
Age	*No.*	*Av. Head Size*	*No.*	*Av. Head Size*	*No.*	*Av. Head Size*
19	17	241.9	70	237.1	52	229.1
20	54	244.2	149	237.9	102	235.1
21	52	241.0	117	236.4	79	240.2
22	50	248.1	73	241.7	66	240.2
23	27	244.6	33	239.0	23	235.0
24	25	245.8	14	251.2	13	244.4
25+	33	248.9	20	239.1	26	243.5
Total	258		476		361	

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[5] Francis Galton, "Head Growth in Students at the University of Cambridge," *Nature*, 1888, 38:14-15.

honor men and the pass men with the remaining honor men occupying an intermediate position. He concludes, "Men who obtain high honors have had considerably larger brains than others at the age of nineteen. . . . Consequently 'high honor' men are presumably, as a class, both more precocious and more gifted throughout than others."

It would appear that Galton tended to emphasize the significance of the largest single difference disclosed, which was at the age of nineteen. However, at the age of twenty-one, where an even larger number of cases are involved, the difference is less than one per cent. (to be exact, the difference is three-tenths of one per cent.). Furthermore, in three of the age groups, 21, 24, and 25 +, there is an actual reversal in the magnitude of the averages in going from pass men to high honor men. In the absence of measures of variability it is impossible to determine the amount of overlapping in the head measurements for the three scholastic groups at any of the ages. Had Galton computed coefficients of correlation (contingency coefficients) for each of the age groups it is certain that all of the coefficients would have been very low. Perhaps in no case would the coefficient of correlation have been higher than + .10 and in several cases it would have approximated zero. Altogether, one can be certain that no close or intimate association between head size and scholastic excellence is revealed by Galton's classical study.

Porter's study of St. Louis school children contained data on the degree of association between one cranial measurement (width of head) and intelligence as determined by grade location for constant chronological age.[6] Subsequent writers have referred to this investigation as supporting the doctrine of a close relation between the two variables in question. Table 14, taken from Porter's paper, shows the

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[6] W. T. Porter, "The Physical Basis of Precocity and Dullness." Trans. of the Academy of Science of St. Louis, 1895, 6:161-181.

TABLE 14

Showing Average Measurements of the Width of the Head of Girls, Age 12, Classified According to School Grade Location. (After Porter 1895.)

School Grade	*No.*	*Arith. Mean*
I	11	...
II	68	143.7 mm.
III	193	144.8 mm.
IV	343	144.9 mm.
V	217	145.5 mm.
VI	89	147.6 mm.
VII	10	...
VIII	4	...

nature of the data upon which this generalization has been freely made. Similar data, not here reproduced, were given for the head width of boys aged ten.

As in Galton's data, we note a general rise in the average head measurement as one passes from the most retarded pupils (in grade II) to the most accelerated pupils (in grade VI). But the differences are slight. The greatest difference is 2.7 per cent. The absence of measures of variability again precludes the possibility of more refined analysis. It is certain, however, that only a very slight positive correlation exists. Uncritical citation of Porter's data as confirming evidence for a close association between cranial capacity and intelligence is unwarranted.

MacDonald's anthropometric measurements of school children in Washington, D. C., like Porter's study of St. Louis school children, included cranial measurements which have frequently been cited as substantiating evidence for an intimate relation between head size and intellect.[7] The data on head size were obtained from measurements of 16,473 white children and 5,457 colored children taken by their teachers, who also turned in estimates of intelligence in terms of a three step scale; bright, dull, and average. Table 15 is intended to indicate the nature of the comparisons presented by MacDonald. The differences between the average head circumference measurements of the bright boys and the average boys are slight. At most of the ages the difference amounts to no more than two or three hundredths of an inch. At only three of the ages is the difference as much as sixteen hundredths of an inch, surely warrant for terming it slight. The differences between the bright or average boys and those labeled dull are larger, being in the neighborhood of two-tenths to three-tenths of an inch. Just how significant such differences are can not be determined in the absence of

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[7] Arthur MacDonald, "Experimental Study of Children," ch. XXI, Report of the U. S. Commissioner of Education, 1897-98, 1:985-1204, Government Printing Office, Washington, 1899.

Table 15

Showing Average Measurements of Circumference of Head of White Boys of American Parents, Classified According to Age and Intelligence. (After MacDonald, 1899, pp. 1058-1059.)

	BRIGHT BOYS		AVERAGE BOYS		DULL BOYS	
Limits of Different Ages Y's M's Y's M's	*No.*	*Av. Circum. of Head In Inches*	*No.*	*Av. Circum. of Head*	*No.*	*Av. Circum. of Head*
5 7 to 6 6	38	20.17	36	20.21	24	20.47
6 7 to 7 6	160	20.51	175	20.35	69	20.32
7 7 to 8 6	249	20.56	285	20.53	73	20.27
8 7 to 9 6	281	20.66	286	20.63	80	20.48
9 7 to 10 6	317	20.77	305	20.75	81	20.55
10 7 to 11 6	272	20.82	320	20.85	78	20.63
11 7 to 12 6	274	21.00	389	20.90	93	20.81
12 7 to 13 6	230	21.06	360	20.96	97	20.83
13 7 to 14 6	180	21.31	311	21.27	98	21.06
14 7 to 15 6	132	21.58	186	21.40	87	21.32
15 7 to 16 6	82	21.80	119	21.64	66	21.55
16 7 to 17 6	29	22.06	59	21.94	32	21.56
Total.......	2244		2831		878	

variability data. The present writer would hazard the guess that only low positive correlations would result from application of correlation formulae to the original data. It is of interest to add that the direction of the differences does not disappear even when social-economic status is controlled by limiting comparisons to children of American parents in the laboring class.

We must not dismiss MacDonald's elaborate study without noting the fact that the inter-racial comparison reveals little or no difference betwen the average head circumference of the colored boys and of the white boys. (See Table 16.) At seven ages the colored boys have greater head size measurements, at one age the two sets of measurements are equal, and at three ages head dimensions of the white boys are larger. At every age the head size of the colored girls is greater than that of the white girls. The largest difference is over half an inch (.56 in.) at the age of seven. If one

TABLE 16

Average Circumference of Head Measurement of White and Colored Children Classified by Age and Sex. (Constructed from MacDonald, 1899, Tables 8, 35, 61, 65.)

	WHITE BOYS		COLORED BOYS		WHITE GIRLS		COLORED GIRLS	
Age Limits *Y's M's Y's M's*	*No.*	*Av. Head Circum. Inches*	*No.*	*Av. Head Circum. Inches*	*No.*	*Av. Head Circum. Inches*	*No.*	*Av. Head Circum. Inches*
6 7 to 7 6	399	20.41	240	20.28	372	19.94	239	20.50
7 7 to 8 6	605	20.51	279	20.51	580	20.13	218	20.51
8 7 to 9 6	638	20.62	280	20.67	662	20.29	203	20.72
9 7 to 10 6	696	20.74	325	20.81	731	20.45	240	20.84
10 7 to 11 6	668	20.81	267	20.95	711	20.55	252	20.87
11 7 to 12 6	751	20.93	278	20.87	667	20.78	271	20.95
12 7 to 13 6	683	21.01	313	21.07	700	20.97	261	21.14
13 7 to 14 6	582	21.25	280	21.31	618	21.18	236	21.48
14 7 to 15 6	398	21.44	220	21.41	484	21.29	166	21.51
15 7 to 16 6	263	21.67	124	21.45	318	21.38	127	21.50
16 7 to 17 6	119	21.87	131	21.95	254	21.55	81	21.74
Total....	5802		2737		6097		2294	

argues that head size varies directly with intelligence then it should follow that colored girls are the mental superiors of white girls and that colored boys at most ages are superior in intelligence to white boys. The conclusion is absurd in the face of the mass of evidence now available which indicates a marked intellectual superiority of the white race when compared with negroes. Altogether, MacDonald's data suggest that head size is a matter of racial heredity and relatively independent of intelligence. The inference is plausible that little significance is to be attached to variations in head size within any given racial group.

Much attention has been given to this problem in the Galton-Pearson eugenic laboratory in London. It was the practice of early workers in the field of anthropology to assess indirectly the intelligence of various racial and nationality groups by means of craniometric measurements. One of the earliest studies from the Galton-Pearson laboratory stimulated by this practice was that of Alice Lee who worked out the standard formula for finding brain capacity from the three head measurements of maximum length, maximum breadth, and auriculo-bregmatic height. This formula involves a five to six per cent. error as shown by measuring the head of a corpse and comparing the resulting cranial index with the cranial capacity determined after removal of the brain by noting the total volume of water displaced by the brain when immersed.

Dr. Lee measured the skull capacity and also obtained rough estimates of the intelligence of sixty men and thirty women.[8] The negative character of the conclusions she draws from these data may be indicated by the following quotation: "It would be impossible to assert any marked degree of correlation between the skull capacities of these individuals and the current appreciation of their intellectual capacities. . . . Although we are dealing with skull capacity, and not brain weight, there is, we hold in our data, material enough to cause those to pause who associate relative brain weight either in the individual or the sex with relative intellectual power. The correlation, if it exists, can hardly be large, and the true source of intellectual ability will, we are convinced, have to be sought elsewhere, in the complexity of the convolutions, in the variety and efficiency of the commissures, rather than in mere size or weight" (p. 949).

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[8] Alice Lee, "Study of the Correlation of the Human Skull." *Science*, n.s. 1900, 12:946-949.

Binet and Simon in their search for ways and means of measuring intelligence devoted a great deal of energy to the investigation of cephalometry as a possible means of differentiating between the feeble-minded and those of normal intelligence. A number of papers were published by them between 1900 and 1910 in *L'Année Psychologique* that described their attempts to utilize head measurement as a test of intelligence.[9] Differences between the feeble-minded and bright children were demonstrated. Bright children were shown to be differentiated much more definitely from average children than the latter were differentiated from the feeble-minded. However, they came to recognize that small differences between averages accompanied by an enormous amount of overlapping indicated that only a very limited contribution could be looked for from the use of head measurements when it was a matter of devising a practical instrument for the diagnosis of feeble-mindedness. Head measurements, they thought, might have a possible usefulness in confirming the results of intelligence tests provided that the retardation in head growth was sufficiently pronounced. It should be borne in mind that Binet in his unwillingness to overlook any possible means of testing intelligence investigated not only head measurements but also physiognomy, cutaneous sensitivity, physical stigmata, graphology, and even palmistry.

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[9] A. Binet, "Recherches sur la technique de la mensuration de la tête vivante," *L'Année Psychol.*, 7:1900; Th. Simon, "Recherches céphalométriques sur les enfants arriérés de la colonie de Vaucluse," *L'Année Psychol.*, 1900, 7:430-489; A. Binet, "Les frontières anthropométriques des anormaux," *Bulletin de la Société libre pour l'étude psychologique de l'enfant*, 1904, p. 430; A. Binet, "Les signes physiques de l'intelligence chez les enfants," *L'Année Psychol.*, 1910, 16, 3-12.

In the 1910 article, Binet reported his conclusions upon the diagnostic significance for intelligence of size and shape of head, face and hand. The preëminent position of Binet in the development of a science of individual differences in intelligence and his contribution to methods of intelligence measurement, justify a review of his work on cephalometry.

Binet employed the sum of five head measures as an index of head size: head length, head height, and three head breadth diameters. It may be remarked that the sum of these measures unduly stresses head breadth. If brachycephaly (broad headedness) should be positively correlated with intelligence to a greater extent than dolichocephaly (long headedness) then Binet's formula would (properly) weight that factor heavily in determining head size. His method of interpreting the obtained head size measurements for any given child consisted in determining the number of years of acceleration or retardation in head size in comparison with standards for normal children, after the manner previously developed by him for interpreting relative intelligence from mental age measurements.

When it came to evaluating the significance of cephalometry for purposes of mental diagnosis, Binet declared that one should not be content with studies of normal children alone but should, in addition, consider the facts revealed by comparative studies of extreme cases. In the case of the heads of blind and deaf children, he pointed out that young blind children and young deaf children, have approximately normal heads and faces, with however, tendencies toward brachycephaly. But by age nine, this characteristic disappears and is supplanted by a general retardation of cephalic development in all diameters. This transition from differences in one direction to differences in another becomes most evident during the adolescent years when smaller than normal head is observed as a general rule. With reference to mentally backward children (morons in special classes in school) he found that only four were one or more cephalometric years accelerated, six were normal, and thirty were one or more years retarded. The findings for children of normal intelligence were in marked contrast; twenty-five were accelerated, three were normal, and nineteen were retarded. He concluded that "the abnormal in school are microcephalic." It is certain that Binet's measurements reveal a difference between the two groups, but it is permissible to question the significance or adequacy of Binet's adoption of years retarded or accelerated as the basis of comparison. In view of the fact that age differences in head size are slight it is inevitable that slight differences in head size between two groups would appear to be rather large in terms of years retarded or advanced. Indeed, the method itself is to be criticized for designating 44 out of 47 normal children as either accelerated or retarded. Even so, it must be admitted that there is a difference in head size, on the average, between normal children and mentally dull children, although once again it proves impossible, from the data as given, to determine the significance of the difference.

Binet published a table which shows what he believed to be the probable relationship between variation in head size and variation in intelligence among normal children. He used a three-step scale for each variable. (Cf. Table 17.) The number of cases involved was not stated. Binet asserted that the correlation is of the same type as that between body size

TABLE 17

Percentage of Children in Each Head Size Group Who Are Retarded, Normal, or Accelerated in School Progress. (After Binet, 1910.)

Scholastic Ability

		Retarded	Normal	Accelerated	Total
Head size	Accelerated ..	20	30	50	100%
	Normal	25	50	25	100%
	Retarded	40	35	25	100%

and intelligence, but is much greater. Unfortunately, we cannot check this assertion since it is impossible to compute in a straightforward way the necessary correlation coefficient. The data were presented as one-way percentages leaving us in ignorance of the actual number of individuals in each head-size group. Without these figures, it would be mere guess-work to assign numerical values to each cell of the table, a necessary procedure for reducing the data to a correlational index.

Binet did emphasize the danger of diagnosing the intelligence of any given child on the basis of head measurements alone, stressing the importance of cerebral "quality" which of course is not revealed by head measurements. However, without further analysis or additional proof, than we have cited, Binet did not hesitate to maintain that cephalometry has value in *confirming* mental diagnosis, especially in cases where there is pronounced cephalometric retardation. To quote: "A cephalic retardation of three years is so frequent with normal children that it may scarcely be taken into consideration. But a retardation of six years or more seems to me to be significant" (p. 11). Binet regarded cephalometry as a secondary aid in confirming a mental diagnosis arrived at by wholly independent means. Further than this he did not go. His treatment of the whole subject is far from conclusive and definite.

As an illustration of attempts to use craniometry in the diagnosis of feeble-mindedness we have selected for citation here the interesting paper of Dr. F. Peterson, a neurologist.[10] This paper reflects a mid-way stage in the gradual transition from extreme phrenological speculation to sober attempts to correlate specific head malformations with particular behavior difficulties such as were current toward the end of the nineteenth century. For example, Dr. Peterson affirmed that "Every segment of the skull represents some particular part of the brain lying beneath it. This may be assumed without proclaiming one's self a proselyte of Gall. . . . The great recent advance in cerebral localization paves the way to a newer and more scientific, though more limited, phrenology" (p. 76).

The influence of phrenological notions is indicated by the detailed description, labeling, and classification of specific skull malformations and deformities. Because of its historical interest, the following list as given by Dr. Peterson is presented:

1. Choemocephalus or platicephalus (flat-head)
2. Leptocephalus (narrow-head)
3. Macrocephalus or hydrocephalus (large head)
4. Microcephalus (small head)
5. Oxycephalus or acrocephalus (steeple-shaped head)
6. Plagiocephalus (oblique deformity, i.e., one side bulging)
7. Scaphocephalus (keel-shaped at top of head)
8. Trigonocephalus (narrow forehead with great occipital width)

In spite of the pains taken to work out such a classification of eccentricities of skull anatomy no attempt was made to link each deformity to a specific behavior disturbance, with the exception of (3) hydrocephalus and (4) microcephalus. An appended table showed various cranial measurements of the heads of thirteen idiots selected because of marked head deformities (five were microcephalic idiots, four were hydrocephalic idiots, and four were illustrative of other types of skull malformation). The scientific value of the table is limited to a demonstration of what cranial measurements can be obtained by deliberately selecting from among the feeble-minded thirteen cases exhibiting in marked degree the particular skull sizes and shapes of the classifications.

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[10] F. Peterson, "Craniometry and Cephalometry in Relation to Idiocy and Imbecility," *Am. Jour. of Insanity*, 1895, 52:72-89.

The quantitative data presented in support of Peterson's main thesis consist of head measurements of eleven male and eight female adult paralytic imbeciles. As typical we may select the head circumference of normal male adults, which is stated to be 55 cm. with a physiological variation between 51.5 and 60.4. The average head circumference of the eleven paralytic male imbeciles is 53.7 with a variation between 51.0 cm. and 55.3 cm. The normal average for women is stated to be 53 cm. and for the eight female paralytic imbeciles 52.3 cm. with a variation between 48.5 and 54.5. On the basis of such slight differences as these between normal persons and *pathological* varieties of imbecility the author confidently concludes: "The above tables prove or assist to prove the interdependence of small-sized heads and mild degrees of feeble-mindedness, congenital or acquired in infancy" (p. 88).

The research report made by Dr. Gladstone of England may be cited as still another illustration of the dependence once placed upon the method of average differences between groups. This report gives twenty tables of results showing average head measurements for a group of medical students and a group of pupils in a boy's school classified on a three-step scholastic scale.[11] Gladstone secured the following head measurements for a relatively small number of subjects: head length, breadth, height, the product of these three diameters (index of cranial capacity), and circumference of head. Students and pupils were classified as Class A, honor students, Class B, students of average mental ability, and Class C, students of inferior scholastic ability. Each table was constructed to show the average, the maximum, and the minimum head measurements for each scholastic class. No standard measures of variability were given. As usual, in relying upon the method of averages in making comparisons, the differences between the averages were shown and exaggerated interpretations drawn from them. Data from Table III for the Middlesex Hospital students may be taken as typical: Average head size of Class A = 4,320 cu. cm., Class B =4,015 cu. cm., and Class C = 3,747 cu. cm. The largest head size was 5,100 cu. cm. and the smallest 3,486 cu. cm. Just how much overlapping in the head measurements occurs for the various scholastic groups compared can not, of course, be determined. That a relationship exists between head size and scholastic ability for Gladstone's data is apparent, but even so the author has tended to exaggerate its amount in the statement: "The tables thus show a distinct correlation between large size of head and high degree of mental ability, this correlation being both absolute and relative to the general size and weight of the body" (p. 345).

In Germany there has been a lively interest in head measurements. One of the most elaborate investigations was conducted by Dr. C. Röse of Dresden.[12] Results for 1,290 boys

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[11] R. J. Gladstone, "A Preliminary Communication on Some Cephalometric Data Bearing Upon the Relation of the Size and Shape of the Head to Mental Ability," *Jour. of Anat. and Physiol.,* 1902-03, 37: 333-346.

[12] Dr. C. Röse, "Beiträge zur Europäischen Rassenkunde," *Archiv. für Rassen- und Gesellschafts-Biologie,* 1905, 2:689-798 and 1906, 3:42-134.

TABLE 18

Showing Average Summed Head Measurements in Centimeters (Length and Width) of 1290 Boys and 1274 Girls Ages 6 to 14 years in Nordhausen Elementary Schools, Classified by Sex and Estimates of Scholastic Ability. (After Röse, p. 761.)

	BOYS		GIRLS	
Classification According to Estimates of Scholarship	*No.*	*Av. Sum of Head Length and Width*	*No.*	*Av. Sum of Head Length and Width*
Very Good	47	32.90	104	32.14
Good	431	32.58	367	32.01
Satisfactory	639	32.47	617	31.82
Unsatisfactory	162	32.42	158	31.72
Very Unsatisfactory	11	31.36	28	31.77
Total	1290		1274	

aged six to fourteen are shown in Table 18. These are representative of the trend of his evidence. At best, the differences in averages are small, and, once more, we note that measures of variability are missing. The deceptive power of slight differences in averages seems no less potent in its influence upon German scholars than upon American! The correlation technique if applied to the original data gathered by Dr. C. Röse would yield coefficients of correlation only slightly greater than zero. Indeed the correlation between these head measurements and estimated scholastic excellence is so slight as to produce actual reversal in the order of the averages for the two poorest scholarship grades among the girls.

Data similar to those of Dr. Röse were presented by Bayerthal in 1906. Working with a smaller group of subjects (234 boys and 153 girls) but controlling the age factor by limiting selection of subjects to a single chronological age (7.5 to 8.5 years), Bayerthal obtained average circumference of head measurements for five scholarship groups ranging from "very good" to "more or less unsatisfactory." [13] The average measurements showed slight differences between successive scholarship groups, indicating the existence of a low positive correlation. However, in 1910, Bayerthal recognized that all levels of intellect may be exhibited by large headed persons but he still insisted that very small headed persons could not be endowed with superior intelligence.[14]

Belief in an intimate connection between head size and intelligence was so widespread among scientific workers, even at the beginning of the twentieth century, that Karl Pearson undertook a very extensive investigation in the hope of definitely clearing up the subject once and for all.[15] The outstanding merits of his classic study are: (1) the large number of cases involved; (2) effective control of age and sex; and (3) expert application of appropriate biometric analyses. It was the first instance of the use of adequate correlational analysis of head measurement-intelligence data.

Pearson collected data from two populations of subjects: 4,500 boys and girls, keeping chronological age constant by selecting twelve-year-olds only; and 1,010 Cambridge University students. Both groups were sorted into a small number of intellectual grades on the basis of teachers' estimates and scholastic records. Three cranial measurements were secured for each subject, and these were tabulated in relation to intellectual status. The relationship between the head measurements and intelligence is reported in terms of the eta coefficient. The correlation ratio method was employed by Pearson as being appropriate for the data in hand since

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[13] J. Bayerthal, "Kopfumfang und Intelligenz im Kindesalter," *Die Experimentelle Pädagogik*, 1906, 2:247-251.

[14] J. Bayerthal, "Kopfgrösse und Intelligenz im Schulpflicten Alter," *Zeitschrift für Experimentelle Pädagogik*, 1910, 10:197-218.

[15] Karl Pearson, "Relationship of Intelligence to Size and Shape of the Head and other Mental and Physical Characters," *Biometrika*, 1906, 5:105-146.

TABLE 19

Correlation Ratio Between Cranial Measurements and Intelligence. (After Pearson, 1906.)

Intelligence and	*Cambridge Students*		*School Boys Aged 12 Years*		*School Girls Aged 12 Years*	
	N = 1010		N = 2298		N = 2165	
	r	P.E.	*r*	P.E.	*r*	P.E.
Cephalic Index	—.06	.02	—.04	.01	.07	.01
Length of Head	.11	.02	.14	.01	.08	.01
Breadth of Head	.10	.02	.11	.01	.11	.01

its use did not necessitate the adoption of doubtful assumptions regarding linearity of relationship. The results are given in Table 19.

A glance at Table 19 reveals the existence of low positive correlations only. The correlations are so low as to preclude the use of cranial measurements in making even rough predictions regarding the intellectual status of individuals. We must regard Pearson's paper as a convincing demonstration that the usefulness of head measurements as indicators of mental ability is practically nil. Pearson himself a bit cynically remarks of his study, "Although I am hardly hopeful, it may help convince the anatomist and old school anthropologist that head measurements are not of real service as intelligence tests."

Pearson's work was followed immediately by a confirmatory paper from Raymond Pearl published during the same year.[16] By way of introduction, Pearl pointed out that up to

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[16] Raymond Pearl, "On the Correlation Between Intelligence and the Size of the Head." *Jour. of Comp. Neurol. and Psychol.*, 1906, 16:189-199. This paper is reprinted as chapter II, *Intelligence and Size of the Head in Pearl's Studies in Human Biology* (The Williams & Wilkins Company, Baltimore, 1924).

1906 only Pearson had made a biometric analysis of the problem. He also asserted that biometric analysis yielding coefficients of correlation is the only adequate method of solving the problem. He then presented conclusions obtained from applying biometric methods of analysis to the data previously published by Drs. G. Eyerich and L. Loewenfeld of Germany in their investigation of the relation between intelligence (as estimated) and head circumference of 935 Bavarian soldiers. The estimates of intelligence were obtained from officers rating their men on a four step scale ranging from "sehr gut beanlagt" to "beschränkt." Eyerich and Loewenfeld, after condensing these ratings into a three step scale containing the categories, very good, good, and weak or feeble, set forth the relationship between these ratings and the head circumference measurements in what we would now term a "scatter-table." They concluded from inspection of these data that there is no definite relationship between intelligence and the size of the head. (See Table 20.) Had their data been presented by the usual method of average head measurements for each intelligence class or grade, they undoubtedly would have fallen under the spell of averages, since slight differences in the median head measurements do appear between the successive intelligence grades.

Pearl was interested to discover whether Eyerich and Loewenfeld's conclusion of no relationship would be borne out by precise biometric methods, so he computed the exact degree of relationship by determining the mean square contingency coefficient. The resulting value was +.14 ±.04, which leads him to say: "From the data available it seems fairly probable that there is a sensible, but *very slight,* positive correlation between intelligence and size of head. . . . It will be understood that any conclusion regarding this matter must for the present be more or less tentative. It is perfectly clear that we are dealing here with a correlation of a

TABLE 20

Scatter Table Showing Relationship Between Officers' Ratings of the Intelligence of 935 Bavarian Soldiers and Head Size. (After Pearl's reconstruction of Data of Eyerich and Loewenfeld, 1906.)

Circumference of Head in mm.	GRADES OF INTELLECT		
	Weak or Feeble	*Good*	*Very Good*
61–61.9	..	..	1
60–60.9	1	2	..
59–59·9	1	18	7
58–58.9	13	66	22
57–57·9	28	136	40
56–56.9	46	182	54
55–55·9	40	112	27
54–54·9	23	61	17
53–53·9	8	19	3
52–52.9	3	2	..
51–51.9	..	..	1
50–50.9	1	1	..
Total	164	599	172
Median Head Size	56.15	56.57	56.70

Mean Square Contingency Coefficient as Computed by Pearl = +.14 ± .04.

very low order, the *general* existence of which cannot be definitely asserted till we have further statistics covering a wide range of social classes of different races" (p. 101). It will be noted that Pearl properly holds up the ideal of determining the precise degree of correlation, whether zero, + 0.05, + 0.09, + 0.14, + 0.19, or some other coefficient.

A survey of the literature makes it appear that Pearson's attempt to put the belief in an intimate relation between head size and intelligence to a crucial test in 1906 was effective in curbing the previous extravagant claims in its behalf.

Whipple cites twenty references dealing specifically with the relation between head size and intelligence. When these references are classified chronologically it is found that five appeared before 1900; 12 from 1900 to 1906 inclusive; and only 3 between 1907 and 1913 inclusive (1913 is the latest date covered by Whipple's Manual).[17] Furthermore, of the three articles appearing between 1907 and 1913, two of them (by Binet and by Bayerthal) represent a recession from earlier and more positive views. As a matter of fact, interest in this problem among scientific workers, so far as it can be inferred from the absence of research articles subsequent to 1906, seems to have been relatively suspended until interest was rearoused by S. D. Porteus in 1918. In the decade following thereafter eight new quantitative investigations appeared in the literature. These now require review.

3. The Researches of S. D. Porteus

Porteus, in collaboration with Dr. R. J. A. Berry, submitted new evidence in 1918 regarding the practical usefulness of cranial measurements in the early diagnosis of feeblemindedness.[18] This paper champions a clinical program for diagnosing mental deficiency which includes head capacity measurements, intelligence test results, and the correlation of these two sets of data with what may be derived from interviews regarding the personal, family, and educational history of each case.

As was essential for their program, Porteus and Berry undertook to provide cranial capacity norms based upon the measurement of the heads of 10,000 children and university students in Australia. A close approximation to the Alice Lee formula No. 14 was employed in determining cranial capacity in each subject. This formula, in its essentials, permits computation of cranial capacity by taking the product of the three principal head diameters, length, breadth, and height. The obtained cranial capacity measurements for each age were arranged in a percentile table so that the *relative* head size of any given subject could quickly be determined by reference to the table.

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[17] G. M. Whipple, *Manual of Mental and Physical Tests*, vol. I (Warwick and York, Inc., Baltimore, 1914), p. 79-91.

[18] Porteus, S. D. and Berry, R. J. A., "A Practical Method for the Early Recognition of Feeble-mindedness and other Forms of Social Inefficiency," Vineland, N. J., Training School Bulletin, 1918, 15:81-92.

Since the whole question of norms is basic for an evaluation of the subsequent extensive work of Porteus and his collaborators, we are forced to point out at the start that only meager information is given regarding the nature of the sampling. We are merely informed that the subjects (Australian) were Victorian public school children and Melbourne University students ranging in age from 7 to 30. The racial and nationality composition of the groups is not stated. No notion regarding the social-economic distribution of cases is afforded other than a statement appearing in a later publication to the effect that 4,177 Victorian State School boys were not included in the norms because they were found to be drawn from a lower social grade, to have a lower head size, and to cease their education at about age fourteen. It would appear, then, that the norms based upon the 2,104 public school boys and university students represent a definite selection from the upper social-economic levels of society. Unless basic principles of selection such as these are described in great detail there arises a grave danger that the norms derived from them may give rise to misleading comparisons when they become the standard for assigning percentile rankings to subjects in America, England, or any other country. We may recall the conflicting conclusions cited in Chapter II, where the question of the existence of deficiency in height and weight among Minnesota institutional cases of feeble-mindedness such as is shown in Wylie's data, depends upon whether Iowa school children or English school children are taken as the standard of comparison.

In their 1918 paper, Porteus and Berry assert that mentally abnormal types will tend to be found above the 90 percentile and below the 10 percentile points. Presumably, they have in mind cases of hydrocephaly and microcephaly as the following evidence would indicate. When mental tests were given to those falling below the 10 percentile point in cranial capacity, it was found that 50 per cent were at distinctly subnormal mental levels and only 5 per cent were above average intelligence. The criterion of mental retardation constituting the subnormal mental level and the degree of mental acceleration which constitutes "above average intelligence" are not stated. When mental tests were applied to those above the 90 percentile point, 14 per cent. were subnormal mentally and 25 per cent. were "above average intelligence." In order to avoid the risk of being unfair the authors' interpretations should be quoted in full: "That one-half of the microcephalic heads are of subnormal intelligence is in accordance with the thesis on which we are working. That all are not so is simply due to the fact that head measurement cannot differentiate between the varying contents of the skull—fluid, neurone, or neuroglia. That a small percentage of the small-headed are distinctly above average intelligence, even to the acquisition of genius, is also in accordance with the known facts, since it is certain that the amount of gray cortical matter, especially of certain regions concerned in some particular phase of mental activity, may exist in unusual abundance; hence the occurrence of genius of the small-headed type, though it should be noted that such a form of genius is often limited to a single subject. That a larger percentage of the macrocephalic heads are above average intelligence is strictly in accordance with known neurological facts. That all are not so, is due to the disturbing influences of excess of cerebrospinal fluid, or varying ratios of neurone and neuroglia; this, it is obvious, head measurement alone cannot discover. For these last reasons it is also to be expected that a certain percentage of the macrocephalic heads would be of subnormal intelligence" (p. 88).

That undue emphasis is placed upon head size alone would appear also from comments regarding the particular University student whose cranial capacity was the smallest of all those measured in the age range 20 to 30. They state: "The University student, who occupies the lowest place, or the 0 percentile, has but 1,272 cu. cm., that is, he has less brain than the eight-year-old normal boy, and is thus some twelve years retarded. To assert or pretend that these facts have no educational significance is the merest stupidity, which it would be folly to refute" (p. 88). One may agree as to the stupidity of denying the educational significance of the fact that a university student may have a head as small as that of an eight-year-old. At the same time, there is nothing to compel acceptance of the inference suggested by the authors. Indeed, the very opposite inference strikes us more forcibly. How else is it possible for an individual with an eight-year-old head size to matriculate at an institution of higher learning unless he be an example of marked discrepancy between head-size and intellect?

In concluding this paper, Porteus and Berry insist that their percentile tables of cranial capacity are distinct aids to the diagnosis of mental deficiency because they afford some clue to the relative development of the supra-granular (educational) and infra-granular (instinctive) layers of the cortex cerebri of the individual. It almost seems as if a view which is hypothesis at the outset is converted by fiat into established fact without the necessary intermediate steps of proof and verification. But the authors do put forward three illustrative examples in support of their position. The first is a case history of the smallest headed university student (previously mentioned) who later was expelled because of improper conduct in an examination. The second is a summary of results obtained from a study of youthful delinquents. The third is a case of a boy with a 30 percentile head size whose misconduct was viewed more charitably by the headmaster after the clinical report was received, and who subsequently became re-adjusted through placement in more congenial work. It should be remembered throughout that the authors are most concerned to convince the reader as to the adequacy of their general clinical procedures rather than merely to defend craniometry. For this reason the critically minded reader experiences difficulty in assessing the psychological significance of cranial measurement as abstracted from their program in its entirety.

In 1919, Porteus published a preliminary report on the head measurements of fifty unselected cases of feeble-mindedness at Vineland.[19] Presumably these included nearly if not all types and kinds of feeble-mindedness, since the subjects were the first fifty to be examined at the Vineland Training School Laboratory during 1919. As a standard of comparison, Porteus used the percentile norms derived from the previous work of Porteus and Berry. The results for the first fifty cases were striking, since there was a pronounced tendency for the feeble-minded to fall into the small-headed class. Twenty-five of the cases (50 per cent.) ranked below the 20 percentile point for normals. Porteus pointed out and stressed the fact that a slightly greater number than chance would account for also deviated in the *opposite* direction from the norm. A slight piling up of the cases seemed to oc-

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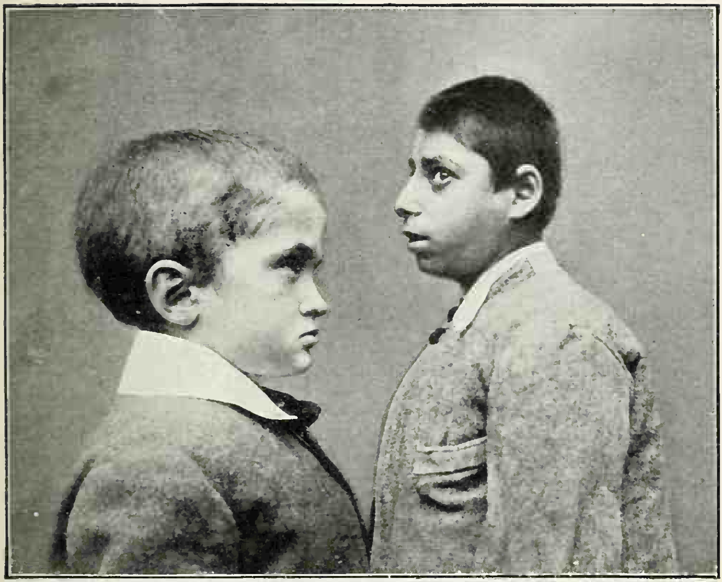
[19] S. D. Porteus, "Cephalometry of Feeble-minded," The Training School Bulletin, 1919, 16:49-72.



Contrasting pathological types of imbecility; hydrocephaly on the left, microcephaly on the right. Reproduced by permission from Tredgold, *Mental Deficiency*, London, Baillière, Tindall and Cox, 3rd Ed., 1920

cur among the highest percentiles. Eleven of the fifty cases (22 per cent.) ranked above the 80 percentile point. But the significance of these figures is very slight indeed, since there is an excess of only 2 per cent. over the expected twenty per cent. in the top two deciles.

Immediately following discussion of these data, Porteus proceeds to explain away the significance of Pearson's classical 1906 study. Referring to the Pearson correlations, he writes: "The lowness of these correlations is often quoted as proof that there is no significant relation between head capacity and intelligence. This is a ridiculous misrepresentation, as it is obvious that these figures simply prove that there is a slight relation between single measurement and intelligence as estimated by teachers." (p. 59). He then points out that an extreme dolichocephaly (long-headed) might be placed among the large heads when length is correlated with intelligence, and the same case placed among the small heads when the measurement is of breadth. However, this criticism, which seems fairly taken, is not of itself sufficient completely to obliterate the significance of Pearson's work, since the latter's work harmonizes so closely with the relatively negative findings of Galton, Porter, MacDonald, Lee, Röse, Eyerich and Loewenfeld already reviewed, and the findings of later workers to be presented in the remainder of this chapter.

Contrary to the Pearson results, Porteus states that he found at some ages a correlation from .3 to .4 between head capacity and intelligence as tested by the Binet and Porteus tests. Unfortunately, detailed data such as correlation scatter tables for each age, the means and standard deviations for head capacity measures and intelligence test scores for each age, and the actual obtained r's for each age are not given. Such data for large samplings of unselected boys and girls at each age would have been of inestimable importance.

Some hesitancy in presenting such correlational material is encountered because of a feeling that the method of correlation is not applicable in view of a suspected non-rectilinear relationship between head size and intelligence. This suspicion derives from the notion that large-headedness and small-headedness alike are associated with subnormal intelligence. Even were this shown to be the case the correlation ratio method could still be applied without any assumptions regarding rectilinearity of relationship. In fact, such methods applied to data showing this swing toward subnormal intelligence for the extremes of head-size would produce larger coefficients of correlation. But the present writer has scrutinized such available correlation scatter table data as are afforded by Pearl's reconstruction of Eyerich and Loewenfeld's data and Reed and Mulligan's cranial capacity and intelligence data (to be discussed presently) without discovering the presence of any such tendency. Certainly a heavy burden of proof rests upon Porteus' views since his evidence consists of a slight trend obtained from the measurement of only fifty feeble-minded subjects. Many more cases representative of all levels of the feeble-minded would be necessary for satisfactory proof. In addition the data obtained should be subjected to analytic treatment in comparison with data for random samplings of children of normal intelligence.

Porteus, again with Berry as collaborator, brought out a more pretentious research paper in 1920.[20] It contains little additional information for our present purpose, since practically all the material on cranial capacity had appeared in Porteus' paper on cephalometry of the feeble-minded. It is this monograph, however, which throws additional light on the derivation of the percentile norms. It would appear from this paper that Porteus in his earlier monograph had committed the error of comparing the head capacity measurements of fifty feeble-minded cases with norms derived from what is now described as "a higher grade type of population where the family surroundings and environment are of a more comfortable character" (p. 38). But in this paper the same error is repeated, since the comparative data for the fifty feeble-minded cases are republished with the same interpretations. As we pointed out before there is ample warrant for believing that the striking deficiency of the feeble-minded cases in head-size is a function of selection, since the cases constituting the norms are admitted to be distinctly superior in social status and in head-size to the State school boys. This cannot act otherwise than to reduce the significance to be attached to the comparison.

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[20] R. J. A. Berry and S. D. Porteus, "Intelligence and Social Valuation, A Practical Method for the Diagnosis of Mental Deficiency and Other Forms of Social Inefficiency," Vineland Training School Research Publication No. 20, May 1920, pp. 1-100.

No correlational analysis of head-size and intelligence data is presented in the 1920 monograph. This is a matter for regret, since the monograph contains a large number of correlations between various psycho-physical tests and intelligence, tending to prove the usefulness of anthropometric tests in diagnosing intelligence, and these correlations could have served as a sort of standard of reference for interpreting the significance of the head capacity-intelligence correlations. In the absence of these crucial correlations we are unable to reach as valid an appraisal of the clinical value of craniometry as we are to pass on the clinical value of the psycho-physical tests. The value of these tests, however, is not the immediate concern of this book.

Before dismissing this monograph it is in line with our interests to comment briefly on the possible significance of the sex differences in cranial capacity shown in the detailed tables. If we permit ourselves to indulge in the sort of logic typical of the Porteus studies we arrive at the inference that the average girl of eighteen (cranial capacity = 1300 cu. cm.) is retarded eight years in brain size, since the average cranial capacity for boys at age ten is 1304 cu. cm. If in turn this amount of cranial retardation is accepted as having genuine intellectual significance then the average eighteen-year-old girl is mentally equivalent to a ten-year-old boy. The fallacy in such reasoning is evident, but only because the example is a caricature. Here, in the Porteus data, we are actually confronted with the same contradiction with reference to comparative brain size and intelligence of the two sexes as that which faced us in MacDonald's data on comparative head size and intelligence in the white and colored races. By what rule of logic can it be insisted that variation in head-size is accompanied by variation in intelligence among boys of the white race, but deny that variation in head size would be accompanied by similar variation in intelligence when we compare boys and girls within the white race or when we compare individuals of the same sex in two different races? Porteus and his followers must be required either to straighten out this logical difficulty or to provide a quality and quantity of empirical evidence hitherto lacking before their assertions can be admitted to the body of attested scientific generalizations.

In 1926, Porteus, this time in collaboration with Marjorie Babcock, published a book entitled *Temperament and Race* in which considerable space is devoted to racial and sex differences in cranial capacity.[21] We might well have expected to find here the answer to the query raised in the preceding paragraph. With reference to sex differences in cranial capacity we note that boys have a greater capacity by some 50 to 60 cu. cm. throughout the age range 6 to 14. Thereafter the curves diverge, revealing an ever widening gap between male and female head size due to the apparent continued growth of the male head coupled with a marked slowing down in rate of female head growth. Indeed, this earlier maturity of the female head size results in an arrest of head size at about the level Porteus had established for Australian aborigines and definitely below that reached by adult male mental defectives. This sex difference cannot be explained away on the basis of differences in bodily size, since it is equally pronounced at age 12 when girls tend to exceed boys in height and weight.

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[21] S. D. Porteus and M. E. Babcock, *Temperament and Race* (Richard G. Badger, The Gorham Press, Boston, 1926), pp. 1-364.

But what mental significance is to be attached to this difference in view of the accumulated mass of evidence pointing to a practical equality of the sexes in measured intellectual ability? Porteus mentions this evidence and freely accepts it as well established. His escape from inconsistency is attempted by insisting that the differential head size is significant not with reference to abstract intellect (he uses the term "learning capacity") but rather with reference to "the maturing of other powers." These "other powers" cover a wide range of non-intellectual personality traits. Hence those traits which are supposed to characterize the feminine mind are the traits which are subserved by a small head and small brain, whereas those traits which are supposed to differentiate the masculine mind are the traits which are dependent upon a large size head and brain. Thus, Porteus assumes that the sex difference in head size is accompanied by a sex difference in personality traits, women being more conscientious, showing less initiative, having less ambition, being more submissive, exhibiting greater suggestibility and greater emotionality, and being less courageous.

In the end, then, Porteus deserts his previous position regarding the intellectual significance of brain size and embraces a substitute theory which stresses brain size in relation to personality traits. In the absence of proof regarding the latter relationship *within each sex,* we can only suspend judgment on this new position. In the meantime, we cannot but doubt the validity of his earlier assertions regarding head size and intellect, since he himself so readily abandons that position when confronted with the fact of sex equality in intellect along with an impressive sex inequality in cranial capacity.

If the reader is inclined to question the wisdom of such a lengthy discussion of Porteus' work the extensiveness of his publications and the difficulty of selecting any one specific set of data for analysis may be pleaded in extenuation. Furthermore, Porteus has been credited by other writers with reëstablishing the validity of head measurements as an indirect measure of intelligence. For example, Hankins in his otherwise admirable book on the racial basis of civilization definitely rejects Pearson's evidence as irrelevant, or at least misleading, and displays a willingness to follow Porteus into what we may leniently term overemphasis of the significance of the head size-intelligence correlation.[22]

4. Additional Studies on Head Size

In 1923 two admirable quantitative studies of the problem were published, one by Murdock and Sullivan [23] and the other by Reed and Mulligan.[24] The former study dealt with height and weight as well as with head diameter measurements and accordingly was reviewed in the preceding chapter. Suffice it to add that they found a correlation of +.22

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[22] F. H. Hankins, *The Racial Basis of Civilization* (Alfred A. Knopf, New York, 1926), see chapter VI, especially pp. 308-312.

[23] K. Murdock and L. R. Sullivan, "A Contribution to the Study of Mental and Physical Measurements in Normal Children," *Am. Phys. Educ. Rev.*, 1923, 28:209-215; 276-280; 328-330.

[24] R. W. Reed and J. H. Mulligan, "Relation of Cranial Capacity to Intelligence," *Jour. Royal Anthropological Inst.*, 1923, 53:322-332.

±.03 between head diameter and I.Q. for some six hundred children. The latter study by Reed and Mulligan was based upon cranial capacity measurements and scholastic performance of 449 male Aberdeen University students whose ancestors were of undoubted Scottish extraction. Cranial capacity was determined by taking the product of head length, breadth, and height, with allowance for thickness of scalp, etc. The rating of scholastic performance was based upon achievement in the professional examinations in anatomy, physiology, and pathology, as graded by a standardized system of marking. These students had all studied the same subjects under similar conditions in the same medical school. The Pearson coefficient of correlation between cranial capacity and intelligence (examination marks) was found to be +.08 ±.03. The partial r between cranial capacity and intelligence with age and stature held constant was +.07. Close scrutiny of the detailed scatter table failed to show evidence of any curvilinear relationship. The low r was not due to the fact that both large-headed and small-headed individuals have low intelligence. The distribution of examination grades was quite normal for students of large head size. A special effort made to disclose any tendency, if present, for students of large head size to break into two subgroups, one exhibiting superior intelligence, the other inferior, showed this not to be the case. Nor was the low r due to undue homogeneity of the group with respect to skull capacity or academic intelligence. In short, none of the phenomena to be looked for on the basis of Porteus' hypotheses was in fact present.

One of the many physical measures obtained by Sommerville (1924) in his study of mental and physical measurements of Columbia University students was head size.[25] With reference to head dimensions and intelligence the following correlations were found: head length, r = +.10; head width, r = +.03; head height, r = +.09. These values correspond to a surprising degree with Pearson's results.

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[25] R. C. Sommerville, "Physical, Motor, and Sensory Traits," *Arch. of Psychol.*, 1924, 12:1-108.

The argument of Porteus that the product of the three head diameters should be far more significant than any single diameter seems to be definitely disproved by the correlations Sommerville obtained. When he used two slightly different methods of obtaining cranial capacity and correlated each with intelligence, the correlations were no higher than those obtained for single diameters. The results are: cranial capacity computed according to the Todd formula, r = +.11; cranial capacity derived by use of the Lee formula, r = +.10.

The precise mathematical relationship between various head dimensions and scholarship for a group of 78 freshmen engineering students at the University of Wisconsin was determined by Sherman[26] and Hull.[27] Some of the coefficients of correlation are surprisingly high when compared with the trend of the available evidence already reviewed. For example, distances from the center of either ear to the forehead (hairline), or to the top of the head (height of head), or to points intermediate between the top of the head and the base of the skull show positive correlations with freshman scholarship ranging from +.23 to +.34. Combining three of these distances with two facial angle measurements by the method of multiple correlation, Hull derived a physiognomic and phrenological index which correlated +.50 with academic marks. As Hull points out, a correlation of this magnitude compares very favorably with the relation usually found between intelligence tests and scholarship. Such evidence taken by itself is impressive. In particular anyone who holds complicated multiple correlation techniques in awe is likely to become excited at encountering such data. But the figure is way out of line with Pearson's findings and with those of other investigators. It may be that the Hull-Sherman correlations are unduly inflated because of some obscure factor, possibly a biased rather than a chance selection of subjects. Also, the small number of subjects must be kept in mind, since the highest coefficient (+.34 ±.067) is only five times its probable error. The unreliable character of these raw correlations necessitates great caution in accepting the multiple correlation figure reported. Hull himself recognizes that a multiple R tends to exaggerate the amount of relation. The optimum weights attached to each component of the battery are those which are found to be best for a particular group of subjects. Whether they should continue to be used depends upon the extent to which the multiple correlation is verified when applied to a new group of subjects. For all these reasons it is premature at this time to attach any great significance to the Hull-Sherman investigation.

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[26] Elsie B. Sherman, *An Experimental Investigation Concerning Possible Correlation between Certain Head Measurements and University Grades,* A. B. Theses: 1923, Univ. of Wisconsin Library.

[27] Clark L. Hull, *Aptitude Testing* (World Book Company, Yonkers, N. Y., 1928), pp. 131-138.

The United States Public Health Service has recently published some data which should be cited to complete the summary of available evidence.[28] The conditions under which the data were collected and the methods of measurement employed were described in chapter II. At this point attention is specifically directed to Table 21 which gives the average head length for each of three I.Q. groups subdivided by sex and age. The results are similar for each group compared. It is certain that only a very slight positive correlation exists between the two variables. Thus this, the latest extensive evi-

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[28] G. A. Kempf and S. D. Collins, "A Study of the Relation Between Mental and Physical Status of Children in Two Counties of Illinois," U. S. Public Health Report, 1929, 44:1743-1784.

TABLE 21

Average Head Measurements for Three Groups of Children Classified According to I.Q., Sex, and Age. (After *U. S. Public Health Report,* vol. 44, no. 29, July 19, 1929, pp. 1774-1775.)

	BOYS			GIRLS		
Cephalic Index	*I.Q. Under 90*	*I.Q. 90–110*	*I.Q. 110 or over*	*I.Q. Under 90*	*I.Q. 90–110*	*I.Q. 110 or over*
Age 8	80.00	81.04	80.20	80.60	80.56	79.76
Age 9	81.47	80.68	79.83	81.35	80.36	79.47
Age 10	81.32	80.72	80.48	80.78	80.88	80.04
Age 11	80.61	81.27	78.90	80.77	79.30	79.79
Age 12	80.65	80.49	79.58	80.23	79.89	79.85
Age 13	80.88	80.29	79.12	80.06	80.36	79.71
Age 14	80.05	80.15	79.58	80.50	79.10	80.85
Head Module * (*in cc.*)						
Age 8	15.17	15.25	15.35	14.68	14.86	14.91
Age 9	15.33	15.29	15.37	14.78	14.96	15.01
Age 10	15.23	15.38	15.43	14.92	14.97	15.08
Age 11	15.50	15.38	15.39	15.05	15.12	15.14
Age 12	15.49	15.49	15.62	14.99	15.14	15.23
Age 13	15.57	15.58	15.68	15.07	15.23	15.34
Age 14	15.51	15.73	15.87	15.17	15.34	15.54

* Module is average of length.

dence based on 2,707 children confirms the main trend of all the results we have reviewed. There is at most only a small positive correlation between head size and intellect, barring pathological cases, of course.

5. Studies of Head Shape

If head size and intellect are correlated only to a slight degree, it would seem most likely that shape of head also would be unrelated to intelligence or at best related to a slight extent only. In the case of head size there might even be good reasons for expecting brain size to be found closely correlated with intelligence, but in the case of head shape there could be little antecedent and theoretical justification for attributing to it any intellectual significance. This is borne out by Pearl's demonstration that skull data for a dolichocephalic race and for a brachycephalic race indicate approximately equal brain weight.[29]

Nevertheless, and in spite of an absence of plausible theory, the literature abounds with emphatic assertions to the effect that dolichocephaly (long-headedness) implies mental superiority, whereas brachycephaly (broad-headedness) implies mental dullness. In fact, belief in this generalization has been so widespread that many authors have attempted to assess the intellectual qualities of whole groups of peoples through craniometric determinations of head shape.

Sorokin admirably summarizes the emphasis which has been placed upon head shape in social theory.[30] He points out that elaborate and widely held theories of Aryan and Nordic racial superiority and theories regarding the social evolution, progress, and degeneration of culture groups have been erected upon a belief that dolichocephaly signifies intelligence whereas brachycephaly connotes mental retardation. It is pointed out that writers belonging to the Ammon-Lapouge school of Anthropo-sociology in particular have sought diligently to demonstrate that dolichocephaly is exhibited not only by the superior races in general, but by the outstanding leaders within a given race, and by the majority of populations whenever social progress and prosperity is marked, as against the social decay and degeneration that results when there is a decline in the proportion of dolichocephalics within a given population.

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[29] Raymond Pearl, *Studies in Human Biology* (The Williams & Wilkins Company, Baltimore, 1924), chapter I, "Weight of Human Brain."

[30] P. Sorokin, *Social Mobility* (Harper & Brothers, New York, 1927), pp. 1-559.

It is not appropriate to enter into a discussion of these social theories since our purpose is restricted to the sole question of fact regarding the amount of relation which may be found to exist between head shape and intellect.

To understand the following brief summary of the evidence, it is necessary to keep in mind the formula for designating head shape by means of the cephalic index (breadth of head divided by length) as well as the usual limits for differentiating between the dolichocephalic, mesocephalic, and brachycephalic types of head. The limits for these three general divisions are as follows:

(a) dolichocephalic or long-headed, cephalic index below 75
(b) mesocephalic or round-headed, cephalic index from 75 to 80
(c) brachycephalic or broad-headed, cephalic index from 80 to 90.

MacDonald's study of Washington school children is one of the earliest quantitative studies of the subject.[31] Curiously enough, MacDonald's conclusions do not accord with the dolichocephalic hypothesis: "Dolichocephaly, or long-headedness, increases in children as ability decreases. A high percentage of dolichocephaly seems to be a concomitant of mental dullness (p. 997). . . . Dolichocephaly seems to be an unfavorable sign, for the bright boys show the smallest percentage, the average next, and the dull the largest percentage. . . . Bright girls have a larger percentage of long-headedness than dull boys" (p. 1005). But MacDonald's conclusions rest upon a very slender basis. Inspection of the several averages which we have brought together in Tables 22 and 23, does not reveal any definite trend in either direction. The relationship between head shape and intelligence is indeter-

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[31] A. MacDonald, *op. cit.*, p. 1004.

TABLE 22

Showing Relation Between Shape of Head and Intelligence for Washington, D. C., Boys. (Constructed from MacDonald, 1899.)

	Dull	*Average*	*Bright*	*Total*
Dolichocephaly	21	17	20	58
Mesocephaly	56	58	121	235
Brachycephaly	59	67	96	222
Total	136	142	237	515

TABLE 23

Showing Relation Between Shape of Head and Intelligence for Washington, D. C., Girls. (Constructed from MacDonald, 1899.)

	Dull	*Average*	*Bright*	*Total*
Dolichocephaly	11	15	33	59
Mesocephaly	70	58	137	265
Brachycephaly	67	56	98	221
Total	148	129	268	545

minate. MacDonald's data do show a pronounced racial difference in head shape, colored boys and girls being much more dolichocephalic than white boys and girls.

We turn to Dr. Röse's lengthy study, since he is representative of European scholars who place such great stress upon head shape as an indicator of intelligence.[32] This study reveals no differences or only slight differences in the cephalic index for pupils classified into separate scholastic ability groups. For example, the average cephalic index for Dresden school boys classified as "Inferior" is 86.4; as "Average" 86.4; "Superior" 86.4; "Very Superior" 85.8. Figures such as these lend cold comfort to enthusiastic champions of dolichocephaly!

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[32] C. Röse, *op. cit.*

A more adequate picture of the relationship is afforded by a scatter table contained in Röse's paper and reproduced here as Table 24. Röse concluded, on the basis of this table, that "the long-heads have the better average school standing, than the middle and short-heads" (p. 768). Even though we accept the data at their face value, it is impossible to accept the conclusion. Mere inspection of the table is enough to show that the relationship between head shape and scholastic ability is very slight. The results for the long-heads fall short of the desired significance because of the extremely small number of cases (54). Virtually only two head shape groups are involved, and the differences in scholastic ability between them are negligible.

TABLE 24

Head Shape and Scholastic Ability of 2805, 6 to 14 year Old Children in the Catholic Elementary School in Dresden. (From C. Röse, 1906.)

			PERCENTAGE DISTRIBUTION BY SCHOLASTIC ABILITY GROUPS			
Head Shape	*No. of Cases*	*Average Scholastic Ability*	*Very Good*	*Good*	*Satisfactory*	*Unsatisfactory*
Dolichocephalic (Cephalic Index under 80) ..	54	5.4	7.4	42.6	48.2	1.8
Mesocephalic (Cephalic Index between 80.0 and 84.9)	846	5.7	2.3	39.4	56.0	2.3
Brachycephalic (Cephalic Index over 85.0) ..	1905	5.8	1.9	41.3	54.2	2.6

Pearson's 1906 study revealed a slight negative correlation ratio between cephalic index and intelligence for Cambridge students and for twelve-year-old school boys and an equally slight positive correlation for the girls. (See Table 19).[33] Sommerville likewise found a correlation of only +.01

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[33] Karl Pearson, *op. cit.*

between cephalic index and the Thorndike intelligence test based on measurements of 105 university students.[34] Finally, Pearson and Moul report a negligible correlation between head shape and intelligence for 616 alien Jewish boys and 580 alien Jewish girls.[35]

B. T. Baldwin included the cephalic index among the physical measurements of the California gifted children.[36] With reference to head shape he stated: "It will be noted that all of these children lie in the upper range of the mesocephalic and the lower range of the brachycephalic, excepting the Scandinavian boys, who approach the extreme brachycephalic type." In California, apparently, mentally gifted children do not tend toward dolichocephaly!

The trend of available evidence is definitely against the dolichocephalic hypothesis. We heartily agree with Sorokin when he says, "The assumption that long-headedness is necessarily connected with extraordinary energy, initiative, progressive mind, talent, and so on is still a mere hypothesis" (p. 236).[37] In disproof of it he cites "the fact that many primitive peoples, the Australians, Eskimos, New Caledonians, Hottentots, Kaffirs, Negroes of West Africa, and so on, have a very dolichocephalic cranial index—from 71 to 74—and yet, they do not exhibit these qualities at all" (p. 236). He even goes so far as to label this point of view, and quite properly, "the dolichocephalic myth" (p. 238).

On the other hand it must be kept in mind that the failure of the evidence to support the dolichocephalic hypothesis does not imply that brachycephaly necessarily goes hand in hand with mental superiority. The facts indicate that such a reversal in position would be equally without foundation. This point has not prevented the appearance of another school of writers who vigorously champion brachycephaly as the sign of superiority in intellect.[38]

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[34] R. C. Sommerville, *op. cit.*

[35] Karl Pearson and Margaret Moul, "The Problem of Alien Immigration into Great Britain, Illustrated by Examination of Russian and Polish Jewish Children," Part II, "On the Intelligence of the Alien Jewish Children," *Annals of Eugenics*, 1925-26, 1:56-127.

[36] L. M. Terman, *et al.*, *Mental and Physical Traits of a Thousand Gifted Children*, Genetic Studies of Genius, vol. I (Stanford University Press, 1925).

[37] P. Sorokin, *op. cit.*

6. Summary

Comparative studies have shown that, from a phylogenetic point of view, increase in head size and cultural evolution have, in general, gone hand in hand. This association, however, does not warrant immediate acceptance of the proposition that, within any given cultural group, variations in head size are necessarily paralleled by variations in intelligence.

A critical review of available evidence tends to dissipate claims put forth in behalf of an intimate relation between head size and intelligence. Although inadequate statistical methods characterize most of the research studies and although no satisfactorily standardized method of measuring head size is adopted in them, it can be said with considerable assurance that whatever positive correlation exists must be of a low order. Our confidence in the validity of this conclusion is increased by the fact that its acceptance frees us from the necessity of accounting for mental equality between the sexes in the face of tremendous sex differences in head size. It also frees us from the necessity of explaining away the possibility that a mentally inferior racial group should exhibit a superior head size. These two instances make the position of those who stress an intimate relationship between intellect and head size embarrassing if not quite untenable. It appears that variation in head size is a function of race, sex, and family stock. It does not vary between individuals in correspondence with intellect.

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[38] For a discussion of the views of Huntington, Taylor, and Dixon in behalf of brachycephaly as a sign of mental superiority see, S. D. Porteus and M. Babcock, *Temperament and Race* (Richard G. Badger, The Gorham Press, Boston, 1926), pp. 316-318.

Not only is head size shown to be of minor importance as a physical correlate or sign of intellect, but the same may be said of head shape. Head shape also varies as a racial characteristic irrespective of the intellectual qualities exhibited by the several racial groups. Within a given racial strain, head shape appears to be indifferently related to intellect.

Chapter IV

ANATOMICAL AGE AND MENTAL AGE

1. The Concepts of Anatomical Age and Physiological Age

THE painstaking researches of the brilliant French psychologist, Alfred Binet, culminated in 1904 in his announcement of what has proved to be an epoch-making discovery in psychology, the invention of the mental-age method of measuring intellectual development. Shortly thereafter, a series of American studies introduced similar concepts for dealing with growth phenomena, anatomical age and physiological age. Rotch, as early as 1910, clearly recognized the age concept of development when he stated, "The number of years that a child has been born is a most unsound rule for placing him with others of the same age either in his studies or in his physical exercises. *There is an age in years, a physiologic age, an anatomic age, and a functional cerebral age.*"[1] (Italics added.)

Naturally, the attention of scientific workers interested in child development immediately fastened upon the possibility of an intimate interrelation between these two indices of development, which if established, would possess far-reaching significance in the better understanding not only of children viewed in the mass, but also of individual children. This significance might find its practical expression in a new era of scientific child guidance, with respect to physical activities, educational adjustment, and vocational possibilities.

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[1] T. M. Rotch, "Roentgen-Ray Methods Applied to the Grading of Early Life," *Am. Phys. Educ. Rev.*, June, 1910, p. 396.

In a series of papers published from 1905 to 1910, Pryor and Rotch set forth their studies of skeletal development and laid a basis for the concept of anatomical age.[2] Papers by Crampton published during 1907 and 1908 added the concept of physiological age based upon studies of the onset of pubescence and the ages at which the various permanent teeth erupt.[3]

2. Measuring Skeletal Development

The researches of Pryor and Rotch demonstrated that there are well-defined stages in the transformation of cartilaginous tissue into osseous or bone tissue, the stages succeeding one another in the same order. Furthermore, the best index of such stages of skeletal development is to be found in the ossification of the eight carpal bones in the wrist, one of which (os magnum) ossifies toward the end of the first year of life, others ossifying at various ages until the last one (pisiform bone) during the eleventh year. Additional clues are afforded by the stage of ossification of the epiphyses of the ulna and radius in the forearm.[4] Rotch took X-ray photographs of the wrists of two hundred children of all ages from birth to puberty and arranged them in such a way as to identify thirteen stages of skeletal development. By reference to this standard photographic scale, X-ray pictures of any given child could be studied and the stage of ossification identified. The accompanying illustration presents three of the original photographs used by Rotch to illustrate three of the thirteen stages in his scale.

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[2] J. W. Pryor, Bulletins of the State College of Kentucky: 1905, "Development of the Bones of the Hand," p. 30; 1906, "Ossification of Epiphyses of Hand," p. 35; 1908, The Chronology and Order of Ossification of the Bones of the Human Carpus, p. 24. T. M. Rotch, "School Life and Its Relation to the Child's Development," *Am. J. Med Sci.*, 1909, pp. 702-11; "The Development of the Bones in Early Life Studied by the Roentgen Method," Trans. of Assoc. of American Physicians, 1909; "Roentgen-Ray Methods Applied to the Grading of Early Life," *Am. Phy. Educ. Rev.*, June 1910; "Conditions Pertaining to the Safeguarding of Early Life from a Pediatric Point of View," *N. Y. Med. Jour.*, June 18, 1910.

[3] C. Ward Crampton, "The Influence of Physiological Age upon Scholarship," Psychol. Clinic, 1907, pp. 115-120; "Physiological Age, A Fundamental Principle," *Am. Phy. Educ. Rev.*, March to June 1908, I, pp. 141-154; II, pp. 214-227; III, pp. 268-283; IV, pp. 345-358; "Anatomical or Physiological Age versus Chronological Age," Ped. Sem., 1908, 15:230-237.

The existence of an intimate relation between anatomic age and mental age is affirmed by Rotch, although he does not offer quantitative data as evidence: "Where there is a delayed mental development, even though the height and weight correspond to the chronologic age, the development of the epiphyses and carpal bones corresponds more to that of the brain than to the general physical condition."[5] Indeed, it is claimed that this relation is so close as to warrant a provisional "grade-anatomical age table" for use as a guide in classifying and promoting school children. In conclusion, Rotch presents data on individual children to support the view that their actual grade location should be determined by their anatomic age.

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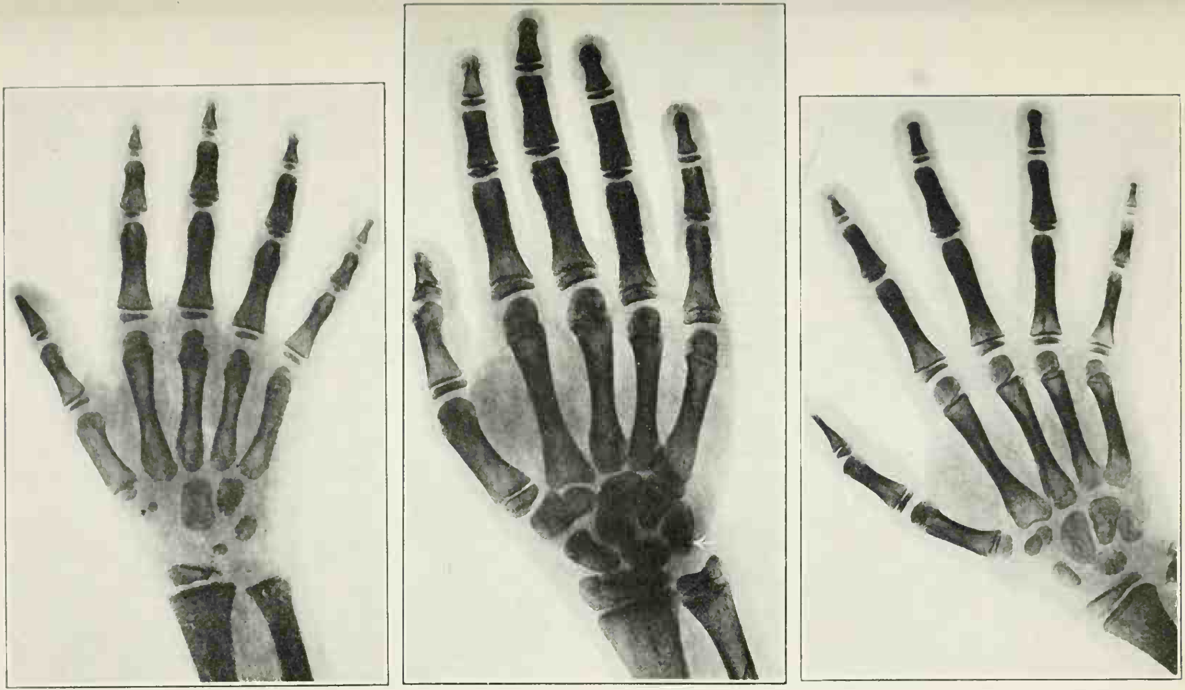
[4] "I have found that the carpal bones and the epiphyses present a complete index of the entire osseous development of the individual and advance in regular progression step by step. It has also been determined that the appearance of the carpal bones and the epiphyses of the radius and ulna represent the stage of development of all the other epiphyses throughout the skeleton, so that the bones of the wrist can be relied upon to judge of the epiphyseal development without having to take Roentgen pictures of the other epiphyses." T. M. Rotch, A*m. Phys. Educ. Rev.*, 1910, 15:397.

[5] T. M. Rotch, *op. cit.*, p. 398.



X-ray pictures showing three of the thirteen stages of anatomical development as determined by Dr. T. M. Rotch. From T. M. Rotch, Trans. of Assoc. of Am. Physicians, 1909

3. Research Studies on the Relation between Anatomical Age and Mental Age

Terman, reviewing the work of Crampton and Rotch, in 1913, emphasized the importance of this whole subject: "Closer investigation of the relations existing between the anatomical, physiological, and mental ages is one of the urgent problems of educational hygiene." [6] Woodrow, in 1919, after pointing out that the anatomical ages of ten-year-old children vary by as much as five or six years, states, "It is highly important that anatomical age be taken into consideration in estimating the child's potentialities. Without a knowledge of a child's anatomical age, we cannot properly appraise his mental ability. I have stated that mental age has significance only when compared with chronological age. It acquires its true significance, however, only when compared with anatomical age." [7] Taking up the question whether there is any considerable correlation between mental age and anatomical age in children of the same chronological age, he states, "Such a correlation would indicate that mental development tends to keep pace with the anatomical, and consequently that anatomical age may be used as an indicator of mental stage. As I shall show, there exists a very decided correlation." He then cites evidence gathered by himself and Severson tending to show that among ten-year-old children those with the lowest anatomical age had a mental age of nine, whereas those with the highest anatomical age had an average mental age of over ten years and eleven months. Although "a very decided correlation" is asserted to exist, no coefficients of correlation are reported.

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[6] L. M. Terman, *The Hygiene of the School Child* (Houghton Mifflin Company, Boston, 1914), ch. VI, pp. 61-72.

[7] H. Woodrow, *Brightness and Dullness in Children* (J. B. Lippincott Company, Philadelphia, 1919), ch. VI, Anatomical Age, pp. 97-122.

Baldwin, in the series of papers already referred to in the chapter on height and weight, emphasizes the importance of physiological age in relation to intelligence, irrespective of the index of physiological age used. In the early 1920's, references began to appear in his papers to X-ray measurements of carpal area reporting an r of + .83 between carpal area and Stanford-Binet Mental Age for a group of 49 girls ranging in age from 5 to 15 years. Detailed evidence in support finally appeared in the Baldwin and Stecher monograph and here, for the first time, the real significance of the asserted relationships can be discovered. The following correlations are reported:

r between X-ray of Carpal Area and Age	+ .92
r " " " " " " Weight	+ .88
r " " " " " " Height	+ .92
r " " " " " " Mental Age	+ .83

The partial correlation between X-ray of Carpal Area and mental age with chronological age held constant turns out to be negligible, i.e., + .09. Since, according to Baldwin and Stecher, "this is the first determination of the interdependence of these physical and mental traits" the apparent absence of relationship should be emphasized, although Baldwin in a chapter summary neglects to do so, simply ignoring the finding. Indeed, within two pages after this negative evidence Baldwin reaffirms allegiance to physiological age:

> "It is evident that mental age ratings by the present scale are the result not only of native intelligence, but also of the degree of physiological acceleration over that which is normal for the age. This latter factor is of extreme importance in any educational or social treatment of the individual."

Baldwin's data are inconclusive, and we may well suspend judgment on the question at issue. As previously pointed out, the inconclusive character of the evidence seems to have been due to the small number of cases, to the distribution of cases over a considerable age range, and to the unreliability of partial correlations under such circumstances.

Recent researches beginning with the comprehensive study of Lowell and Woodrow in 1922 tend to bring order out of chaos by their adoption of more thorough-going research techniques. The result is that the question has been lifted out of the obscurity in which it floundered for some fifteen years. The earlier claims, supported only by asseveration and deceptive statistical averages, have yielded before the correlational method.

Radiographs of hands and wrists, records of permanent teeth, and Kuhlmann-Binet Mental Ages of 402 school children ranging in age from 5½ to 11½ were secured by Lowell and Woodrow.[8] The matter of age range was controlled by reporting correlations for specific age groups only. The principal correlations for seven and one-half year old boys and girls (from 7 years 0 months to 7 years 11 months) are presented in Table 25. Regarding the correlations between these two indices of anatomical age and I.Q. the authors state: "The coefficients of correlation finally obtained speak for themselves. To the writers they seem small —disappointingly so." They further point out that the coefficients themselves are statistically unreliable, since the probable errors are so relatively large. It is to be noted that the correlations between carpal age and number of permanent teeth suggest the relatively independent variability of these two indices of physical development. Additional data, published in the same paper, suggest a rather low correla-

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[8] F. Lowell and H. Woodrow, "Some Data on Anatomical Age and Its Relation to Intelligence," *Ped. Sem.*, 1922, 29:1-15.

TABLE 25

Coefficients of Correlation between Carpal Age, Number of Permanent Teeth, and Intelligence Quotients for 62 Girls and 40 Boys. (Lowell and Woodrow, *Ped. Sem.*, 1922, 29, 1-15.)

r between	*Girls* Age = 7½ yrs. N = 62	*Boys* Age = 7½ yrs. N = 40
Carpal Age and I.Q.	.23 ± .09	.15 ± .10
No. Permanent Teeth and I.Q.	.12 ± .09	.21 ± .09
Carpal Age plus No. Permanent Teeth and I.Q.	.22 ± .09	.29 ± .09
Carpal Age and No. Permanent Teeth	.20 ± .09	—.03 ± .10

tion between height and carpal age and only a very slight relationship between height and I.Q.

It is evident that the work of Lowell and Woodrow also leaves the subject in an unsettled state, although strongly suggesting that previous interpretations of available evidence had exaggerated the degree of relationship between anatomical age and intelligence. There is also and for the first time, the suggestion in somewhat definite terms, that the various indices of physical development are far from being intimately related, and that this assumption which had been tacitly adopted by most of the previous writers must itself be subjected to thorough-going examination.

The elaborate growth investigation, conducted by Dearborn and his associates at Harvard University, yields significant data for our present purpose. Prescott used ossification ratio (ratio of ossified area to size of wrist bone area) as the index of anatomical age.[9] The Dearborn Revised

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[9] D. A. Prescott, "The Determination of Anatomical Age in School Children and Its Relation to Mental Development," Harvard Monographs in Education, Cambridge, Mass., 1923, series 1, no. 5.

Group Intelligence Test and the Otis and the Detroit Primary Group Intelligence Tests gave indices of mental development. Whenever there was serious disagreement between the group tests, the Stanford-Binet test was applied and the resulting mental age used. For four groups of subjects (from 55 to 76 cases in each group) varying from 9 to 18 years of age the partial correlations between anatomical index and mental age with chronological age constant were: — .05; + .12; + .30; and + .33. Less ambiguous results are reported for six groups by holding chronological age constant experimentally rather than statistically. These are reproduced as Table 26. These coefficients range from + .03 to + .28. The average of these six coefficients is + .16, a value which corresponds fairly well with that found by Lowell and Woodrow. We must recognize, however, that only one of the six coefficients is as much as four times its probable error. For this reason we must be content with the conclusion that there is a slight positive correlation between anatomical index and mental age within homogeneous age groups. Whether the actual correlation is + .03 or + .23 or somewhere intermediate can not be determined from the data at hand.

TABLE 26

Coefficients of Correlation between Anatomical Index and Mental Age for Six Homogeneous Age Groups. (Prescott, Harvard Monographs in Education, 1923, Series 1, No. 5.)

Group	*Sex*	*No. of Cases*	*Chronological Age Range*	*r between Anat. Index and M.A.*
1	F	122	6 yrs. 3 mos. to 6 yrs. 8 mos.	.28 ± .08
2	F	125	6 " 9 " " 7 " 2 "	.13 ± .09
3	F	150	7 " 3 " " 7 " 8 "	.23 ± .04
4	F	76	7 " 9 " " 8 " 2 "	.14 ± .11
5	M	91	7 " 9 " " 8 " 2 "	.14 ± .10
6	M	151	6 " 3 " " 6 " 8 "	.03 ± .08

TABLE 27

Coefficients of Correlation between Ossification Ratio and Mental Age for 220 Boys and 220 Girls of the Ages 7 to 17 Inclusive. (Freeman and Carter, *J. of Educ. Psych.*, 15, 1924, 257-270.)

O.R. = Ossification Ratio. M.A. = Mental Age.
C.A. = Chronological Age.

Correlation between	*Boys*	*Girls*
O.R. and M.A.	.73	.75
O.R. and C.A.	.85	.87
M.A. and C.A.	.82	.83
O.R. and M.A. (with C.A. constant)	.08	.09

An equally important contribution is that of Freeman and Carter who report correlations between ossification ratio and mental age for 220 boys and 220 girls distributed uniformly over an age range from 7 to 17 inclusive.[10] These correlations are presented in Table 27. If we may trust the evidence of these partial correlations, they point unmistakably to the fact that children who are physiologically accelerated are not those who are mentally accelerated in comparison with others of the same age. Anatomical development and mental development are thus shown to be independently variable. Freeman and Carter point out without hesitation that there seems to be little warrant in the use of anatomical age instead of chronological age in the formula for I.Q., and there is even less warrant for using anatomical age in school grade classifications.

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[10] F. N. Freeman and T. M. Carter, "A New Measure of the Development of the Carpal Bones and Its Relationship to Physical and Mental Development," *J. of Educ. Psychol.*, 1924, 15:257-270. Two papers on the reliability of the techniques used by Freeman and Carter in obtaining ossification ratios from radiographs of the wrists should be cited. Joseph C. McElhannon, "The Invalidity of the Inspectional Method of Ranking Radiographs of the Carpal Area of the Wrist," *J. of Educ. Psychol.*, 1926, 17:77-85. This paper shows that a composite ranking of radiographs (a combination of separate rankings each based upon one of six points of observation) correlates + .98 with a general ranking by general impression. However, general impression rankings correlate with actual measurement ratings (by means of a planimeter) from + .41 to + .91 for a series of homogeneous age and sex groups. Hence, the need for careful measurements rather than inspection. T. M. Carter, "Technique and Devices Used in Radio-graphic study of the Wrist Bones of Children," *J. of Educ. Psychol.*, 1926, 17:237-247. Describes in detail the standard procedure in making the X-ray pictures and the method of measuring the films and calculating the "ossification ratio." Reports a correlation of +.97 between the results for radiographing and measuring and then re-radiographing and measuring the same 15 hands, also a correlation of + .96 between the results secured by two workers who independently radiographed and measured the same hands.

Simultaneously with the announcement of the results obtained by Freeman and Carter, we are presented with what would seem to be the most conclusive investigation yet undertaken in the work of Gates and his students at Columbia.[11] This work is of great importance in spite of the relatively small number of subjects because of the comprehensive character of the investigation. The age factor is controlled through experimental selection and use of the partial correlation technique. Here, for the first time, we are able to get a fairly adequate picture of the intercorrelation of the various measures which have been proposed as suitable indices of physical development together with the correlation between these several physical indices and mental, emotional, social, and educational maturity ratings.

The 115 subjects were pupils in three classes at the Horace Mann School at the fourth grade level and in the kindergarten. These are subdivided by sex and school status so that four groups of children emerge in the study as follows: 30 kindergarten boys of an average age of 5.66

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[11] A. I. Gates, "The Nature and Educational Significance of Physical Status and of Mental, Physiological, Social, and Emotional Maturity," *J. of Educ. Psychol.*, 1924, 15:329-358. Also, A. I. Gates, G. A. Taylor, E. Bocker, and D. Van Alstyne. "Educational Significance of Physical Status and of Physiological, Mental, Emotional, and Social Maturity," *Teachers College Record*, 1924, 25:223-240.

years (Av. Dev. = 0.63); 28 kindergarten girls of an average age of 5.72 years (Av. Dev. = 0.67); 27 fourth grade boys averaging 9.66 years in age (Av. Dev. = 0.56); and 30 fourth grade girls averaging 9.50 years in age (Av. Dev. = 0.59). The fact that these children, on the average, represent a somewhat rigid selection in the direction of mental and social superiority is somewhat unfortunate, since the possibility exists that a random sampling of children of the given age levels might have resulted in somewhat higher correlations.

Coefficients of correlation were worked out between the several variables for each of the four subgroups separately, with age held constant by the usual formula for partial correlation. The effect of holding age constant could not have been great, since each sub-group is fairly homogeneous as regards age. The coefficients of correlation as reported represent the average of the r's for the four sub-groups.

The measures of physical status included: ossification ratio,[12] height, weight, chest girth, lung capacity, strength of grip, and index of nutrition.[13] Mental ability was measured by the Stanford-Binet Scale. Mental maturity was estimated by the several teachers judging on the basis of common sense, understanding, critical attitude, initiative, perseverance, and responsibility in mental activities. Social maturity was similarly estimated by the teachers on the basis of responsibility for own acts, property, hygiene, coöperation, leadership, and respect for law and order. Educational maturity ratings were based on estimates of school success. Educational achievement was assessed by the use of objective, standardized subject-matter tests. Emotional maturity was estimated by the teachers taking into consideration absence or presence of excessive emotionality, proper responsiveness, evenness of responsiveness, and emotional maturity versus babyishness. Physical vigor was estimated by the teachers basing their judgments upon evidence of health, vitality, stamina, and efficiency in the day-by-day school activities.

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[12] These photographs were taken by the Department of Roentgenology of the Vanderbilt Clinic which is associated with the College of Physicians and Surgeons of Columbia University. The pictures were taken at exact natural size and were measured by a planimeter permitting computation of the ratio of ossification of wrist bones to total wrist bone area.

[13] Actual weight subtracted from the norm as found in the Thomas D. Wood Height and Weight Table.

The main correlations that we are most concerned with are presented in Table 28. Ossification ratio correlates with

Table 28

Coefficients of Correlation Between Physical Traits and Various Maturity Indices. (After Gates, *J. of Educ. Psychology,* 1924, 15, 329-358.) Note: Each r is the average of four r's computed for each of four homogeneous sex and school groups, in each case age being held constant.

Physical Traits	THE VARIOUS MATURITY INDICES						
	Binet M.A.	*Mental Maturity*	*Social Maturity*	*Educ. Maturity*	*Educ. Achievement*	*Emotional Maturity*	*Physical Vigor*
Ossification Ratio	.11	.15	.24	.15	.16	.20	.15
Height	.06	.11	.11	.07	.01	.15	.18
Weight	.10	.13	.09	.17	.07	.17	.25
Chest Girth	.09	.09	.15	.14	.03	.17	.19
Lung Capacity	.09	.09	.12	.06	.00	.11	.22
Grip	.06	.07	.08	.15	.15	.05	.31
Nutritional Status	.13	.15	.18	.17	.15	.15	.37

Binet mental age to the extent of + .11. It correlates with the other maturity indices only slightly more. Indeed, the correlation between ossification ratio and physical vigor is only + .15. We may conclude then that in this study, as in all previous investigations, the correlation between anatomical age and mental age or any other feature of mental, emotional, or social development is definitely positive but very, very slight. Not only is there an absence of appreciable relation between ossification ratio and mental age, but also there is an equally impressive absence of marked relationship between any of the other six physical traits and mental age.

The absence of marked relationship between these physical traits and the physical vigor ratings is due in large measure to the fact that these physical traits themselves are not closely intercorrelated, and therefore are apparently far from constituting equivalent and interchangeable indices of physical development. This is shown most clearly, perhaps, by the fact that these physical measurements, properly weighted and combined by multiple correlation technique into a single index of physical development, correlate to the extent of + .61 with the physical vigor ratings. This fact is of the utmost importance to pediatricians, child hygienists, and directors of physical education. It necessitates abandonment of the current practice in relying upon one or two indicators of physical status and requires substitution of a combined index composed of many indicators of physical status.[14] There is need for an extensive coöperative research program designed to explore thoroughly the possibilities of predicting physical fitness, stamina, and vigor through a combination of tests selected from every conceivable variety of physical test by the statistical method of partial and multiple correlation.

Not content with the apparent absence of close relationship revealed by the correlations in Table 28, Gates computed the maximum possible correlation between mental age and all the physical traits taken together. He found an R of only + .21. This may be accepted, for his data, as the utmost correlation to be expected between physical development and mental development.

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[14] Gates suggests that height, weight, and ossification ratio should not be combined, since they are too closely intercorrelated. A better battery of physical tests for predicting physical fitness would be nutrition, grip, and weight; or nutrition, lung capacity, and height.

Physical tests do not facilitate prediction of educational achievement. Mental age alone correlates + .60 with educational achievement. When all the physical measures are added to, or combined with mental age, the multiple R with educational achievement becomes only 3 points higher, i.e., + .63.

The evidence so far presented is impressive in its cumulative denial of any close association between anatomical age and mental age. One additional study has appeared since the above studies were published and is included here for the sake of completeness. Abernethy, in 1925, computed the coefficient of correlation between ossification ratio and Stanford-Binet mental ages for 317 girls in the University of Chicago Laboratory Schools and found consistent negligible correlations for both young girls and adolescent girls.[15] The partial correlation between ossification ratio and mental age (chronological age constant) for 120 girls, aged 6 to 12 inclusive, was + .02 ± .06. For the remaining age groups the correlation was computed for each age separately with the following results: age 13, $r = -.14 \pm .10$; age 14, $r = -.14 \pm .08$; age 15, $r = -.17 \pm .12$; age 16, $r = -.02 \pm .10$; and age 17, $r = +.04 \pm .11$. One other point brought out in this study confirms Gates' findings, namely low correlations, in general, between the several physical traits measured (height, weight, dentition, pubescence, ossification ratio).

The research of Gates and Abernethy has rendered a distinct service to modern science in demonstrating that growth is specialized and has many phases, necessitating an analytical approach to the individual. No one questions but that physical measurements, when properly combined, are extremely valuable in appraising physical development and fitness, regulating diet, specifying kinds and amounts of exercise, and in diagnosing and correcting physical defects. But we may now legitimately challenge all claims that such physical measures are of practical value in classifying children intellectually, scholastically, socially, or emotionally.

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[15] E. M. Abernethy, "Correlations in Physical and Mental Growth," *J. of Educ. Psychol.*, 1925, 16; 458-466 and 539-546.

4. Pubescence as an Index of Physiological Development

An even stronger position is taken by Crampton in his advocacy of the onset of pubescence and eruption of teeth as the most important indices of development. "In the future, all of our thought concerning the years nine to seventeen must be released from the idea of chronological age. Statistics for groups of individuals respecting weight, height, strength, scholarship, mental or physical endurance, medical or social conditions that are not referred to physiological age are inconsequential and misleading."[16] At the outset of his 1908 paper in the Pedagogical Seminary he states even more specifically the proposition that "Physiological Age should be taken as a basis for all record, investigation, and pedagogical, social, or other treatment of children."

In a series of four papers published in the American Physical Education Review, Crampton gives a most comprehensive outline of his position together with supporting evidence. Table 29 presents, in brief, data regarding the transition from childhood to full adolescence. In this table

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[16] C. W. Crampton, "The Influence of Physiological Age Upon Scholarship," *Psychol. Clinic*, 1907, 1:120.

TABLE 29

Data Relative to the Onset of Puberty in Boys. (After Crampton, *Am. Phys. Educ. Rev.*, 1908, vol. XIII).

	PHYSIOLOGICAL GROUPS		
Age in Half Years	*Pre-Pub.* *1*	*Pub.* *2*	*Post-Pub.* *3*
12.75	69%	25%	6%
13.75	41	28	31
14.75	16	24	60
15.75	5	10	85
16.75	1	4	95

those classified in Group 1 are prepubescent (absence of pubic hair), those in class 2 constitute a maturing class (each case being in a doubtful class as regards amount of pubic hair), and those in class 3 are labeled postpubescent or fully matured. Variability in the onset of puberty is striking, extending over a normal range of 8½ years.

The relation between pubescence and the factors of weight, height, and strength of grip is shown in a series of correlation scatter tables. Since no coefficients of correlation were computed, one is forced to guess the amount of actual relationship, a rather hazardous undertaking at best. On the basis of such a guess it would seem that a rather definite positive relationship does exist among these factors.

In presenting the facts regarding relationship between pubescence and scholarship, correlation scatter tables unfortunately are not given, a method similar to that of Porter being utilized.[17] In this case the percentages of pubescents in various high school terms or semesters are given for each age group. Apparently a relationship exists, but its amount is indefinite. Also another method is utilized whereby the number of cases is given within each physiological group who fail specified numbers of hours irrespective of status in high school. This method yields the following straightforward summary: 34 per cent. of prepubescents fail 10 hours or more, whereas only 24 per cent of postpubescents fail 10 hours or more. However, 33 per cent. of pubescents and 30 per cent. "just arrived" postpubescents likewise failed 10 or more hours. These slight differences do not justify such a positive conclusion as the following: "Postpubescents are different from prepubescents mentally as well as physically, and the difference is enough to cause us to take it into account whenever we make any observations whatsoever upon mental characteristics of the ages about puberty."

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[17] In discussing scholarship as a criterion of mental ability Crampton makes this shrewd observation: "It does, however, stand for the individual's ability, to adapt himself to his immediate environment and to win success in his immediate sphere. It is a measure of application, ability, and cleverness."

In another section of his paper Crampton rather crudely but nevertheless ingeniously demonstrates that the relationship between height or weight and grade location is due to the factor of pubescence. For example, if boys of a given half year age group are classified into three pubescent groups and then reclassified according to grade location (semester) in high school the average weights for any one pubescent class do not increase from semester to semester. He argues from this that the relationship between weight and scholarship is secondary and produced by the phenomenon of pubescence itself. However, we can never determine the actual interrelationships involved by this method, since the relationship between weight and scholarship itself is so much less than Crampton and others thought. Had the original data for weight, scholarship, stage of pubescence, and age been subjected to modern refinements of correlation and partial correlation technique, we would then possess definite insight into the relationships involved. But Crampton rejected the correlation method, stating in a footnote: "The treatment of these subjects has been largely mathematical, but the very minimum amount of this kind of exploitation has been attempted. The correlation index of Pearson and that of others could have been used throughout but would add but little to the clearness of result." Against this point of view the writer would emphasize the probability that the exaggerated ideas of Crampton would never have been promulgated had the method of correlation been relied upon as the chief tool of analysis.

Crampton was mainly interested in demonstrating that the phenomena of pubescence are of primary importance as compared with height or weight. He fails, however, to explain the universal, though slight, positive correlation between these two physical traits and grade location found by all workers using the Porter method even when those studies are confined to children who have not reached the age of puberty. Indeed, the correlation between height and weight and grade location seems to be present in the ages 7 to 11 to as great an extent as in the ages 12 to 16. At all events, as we have shown, the relationship itself is only slight at any age.

Only two attempts to put Crampton's program into practical operation have come to the writer's attention. Foster, in 1910, reports an experiment in which high school freshmen were classified upon entrance into homogeneous physiological groups from the most mature to the least mature with the result that morale was improved as shown by a lower failure rate and fewer leaving school.[18] However, the least mature classes, contrary to expectations, actually did superior scholastic work. King, in 1914, reports a similar experiment in which a two step scholarship scale irrespective of grade was used along with estimated physiological age (physical examinations were not resorted to). In general, there is a slight positive correlation between apparent physiological maturity and scholastic excellence although no correlation coefficients were computed.[19]

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[18] W. L. Foster, "Physiological Age as a Basis for the Classification of Pupils Entering High Schools," *Psychol. Clinic*, 1910, 4:83-93.

The only definite correlational study on this subject with which the writer is acquainted was conducted by Abernethy.[20] The subjects were adolescent girls attending the University of Chicago Laboratory Schools. Age of pubescence was determined by age of onset of menstruation and was correlated with Stanford-Binet mental age for each of four age groups from 14 to 17 inclusive. This experimental control of the troublesome chronological age factor is superior to partial correlation technique. For this reason her results are presented in detail as follows:

		Chronological Age			
		14	15	16	17
Correlation between mental age and age of pubescence	N	45	27	44	33
	r	+ .02 ± .10	+ .03 ± .13	— .09 ± .10	— .33 ± .10

These correlations are so low as to justify the conclusion that there is negligible relation between early or late pubescence and mental development. This correlational evidence is all the more convincing in the light of comparative data submitted for a group of 35 thirteen-year-old girls. This group contained 23 prepubescent girls and 12 postpubescent girls. The postpubescent girls, on the average, were found to be superior in height, weight, and ossification ratio, yet there was a 1 point superiority of the prepubescent girls in median I.Q. Early sexual maturity is thus shown to be associated with accelerated physical development but to be indifferently related to accelerated mental growth.

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[19] Irving King, "Physiological Age and School Standings," *Psychol. Clinic*, 1914, 7:222-229.

[20] E. M. Abernethy, "Correlations in Physical and Mental Growth," *J. of Educ. Psychol.*, 1925, 16:458-466 and 539-546.

Since writing the above, a correlational study by Viteles has appeared which fully confirms Abernethy's results.[21] A total of 236 first-year students in a Normal School for Women in an eastern city were studied. These women ranged in age from fifteen years and eleven months to twenty-four years. In every case sex maturity had been attained. The Brown University Psychological Examination was employed to yield ratings of intelligence. The Pearson coefficient of correlation between age of pubescence (age of onset of menstruation) and intelligence rating at time of the study was $+ .01 \pm .043$. The correlation between age of pubescence and scholastic achievement in Normal School was $- .04 \pm .043$. It is obvious that these correlations indicate the absence of any significant functional relationship between age of onset of pubescence and subsequent mental status during late adolescence.

In view of Crampton's insistence that there is a functional relationship between mental development and pubescence, it is pertinent to inquire into the known facts in those cases where pubertal development has been precocious. Stone and Kulmann made a careful study of the available literature dealing with such cases but found that only 62 out of 190 case descriptions contained sufficient psychological data to permit even rough estimates of mentality.[22] Illustrative of this condition is a case described by Tierney.[23] A boy, of American parentage, was four years and four months old at time of examination. At birth, he weighed 12.5 pounds, at the end of the first year 21 pounds, second year 42 pounds, third year 52 pounds, and at time of examination 81 pounds. At time of examination the boy's height closely approximated that of 10-year-old American boys. His weight was equal to an eleven or twelve-year-old. Ossification of wrist bones equaled that of a twelve-year-old boy. Although no hair had appeared on the chest, there was increased growth of hair on his legs and arms, and the growth of pubic hair was extensive. Penis and testes are reported equal to those of the normal adult. In contrast to this phenomenal acceleration in physical development, it is stated that mental retardation was apparent, although he is reported to have begun talking at the age of twelve months. A photograph of this boy which appears in Tierney's article permits comparison between the physical development of this boy and that of a normal four-year-old boy as well as a comparison with a normal ten-year-old boy, revealing the extent to which physical acceleration may take place at the tender age of four years and four months.

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[21] M. S. Viteles, "The Influence of Age of Pubescence Upon the Physical and Mental Status of Normal School Students," *J. of Educ. Psychol.*, 1929, 20:360-368.

[22] C. Stone and L. Doe-Kulmann, "Notes on the Mental Development of Children Exhibiting the Somatic Signs of Puberty Praecox," *Twenty-seventh Yearbook of the Nat. Soc. for the Study of Education*, Part I, 1928, pp. 388-397.

In studying reported cases in the literature Stone and Kulmann were constantly on the lookout for evidence which would have a bearing upon the mental status of each subject. Of the 62 cases containing information which could be used in estimating probable mental development, Stone and Kulmann conclude that 21.3 per cent. were above average in intelligence, 37.7 per cent. were average, and 41.0 per cent. were below average. Since these figures reflect the remarks and recorded observations of the examining physicians, we may conclude that the consensus of opinion of physicians fails to substantiate the view that there is a necessary relationship between mental precocity and sexual precocity. Indeed, the trend of opinion points toward a slight negative relationship, a finding which runs directly counter to Crampton's generalization.

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[23] J. L. Tierney, "Pubertas Praecox," *Med. Clin. North Amer.*, 1922, 6:31-60.

Another point brought out by Stone and Kulmann has to do with the possible rôle of heredity in the production of puberty praecox. Apparently, this condition is not hereditary but due rather to pathological development and malfunctioning of the glands of internal secretion. If this be so, then we possess added evidence suggesting that mental development and physiological sex development are independent variables.

Unfortunately, Stone and Kulmann could find only six cases of puberty praecox upon which standardized intelligence tests had been used. They urge the importance of having such cases studied by psychologists as well as by endocrinologists and physicians in order to ascertain more definitely whether or not marked spurts in physical and physiological development are accompanied by marked acceleration in mental development.

Psychological examinations of two cases of puberty praecox have been reported in considerable detail by Gesell of the Yale Psycho-Clinic.[24] Both were girls. Menstruation began at 3 years, 7 months in one case and at 8 years, 3 months in the other. In the former case, psychological examinations were made at 4, 5, 6, and 7 years of age. In the latter case, psychological tests were administered at ages 5 and 8 (before the onset of puberty), and again at ages 10 and 11 (after the onset of puberty).

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[24] A. Gesell, "Influence of Puberty Praecox Upon Mental Growth," Genetic Psychol. Monographs, no. 6, vol. I, Nov. 1926, also by same author, "Precocious Puberty and Mental Maturation," *Twenty-seventh Yearbook of the Nat. Soc. for the Study of Education*, Part I, 1928, pp. 398-409.

The four examinations of the first case indicate that this girl, pubescent at the age of 3 years and 7 months, showed no tendency for mental development to keep pace with her greatly accelerated physical and physiological development. Summarized results of the detailed psychological examination indicate that the intelligence of this girl tended to be average or slightly below average throughout the four-year period following the onset of puberty.

The mental development of the second case is of even more interest, since the psychological tests were administered both before and after sex maturity was instated. Furthermore, the physical development of this child was not precocious when first tested at five years and nine months. Indeed, height and weight measurements revealed that she was at that time only average or slightly below average in these respects. The second examination, made at the age of eight years, did not include physical measurements. Three months later menstruation began, and when reëxamined at the age of ten years and two months a marked change in physical development was revealed by her weight measurement. She now weighed 93 pounds which is equivalent to the normal weight for fourteen-year-old girls. At this time her height was average for her age.

No spurt in mental development was observable throughout the time intervals mentioned. At five years and nine months of age she was definitely mentally retarded, exhibiting an approximate mental level of 2.25 years which yields a Gesell developmental quotient (roughly equivalent to I.Q.) of 32. At eight years of age her mental age was 2.75 years, yielding a developmental quotient of 34. At the age of ten years and two months she was found to possess a mental age of 3.5 years, corresponding to a developmental quotient of 35. Finally, when reëxamined for a fourth time at the age of eleven years and one month, her mental age was 3.5 years with a developmental quotient of 32. Thus, all psychological tests given from the age of five to the age of eleven point to a condition of imbecility, the degree of relative brightness, or rather dullness, remaining constant. It is quite evident that sudden acceleration in physical and physiological development failed to be accompanied by any corresponding spurt in mental development.

Stone and Kulmann's critical evaluation of the evidence contained in published case histories and Gesell's detailed study of two cases of puberty praecox point definitely to the conclusion that mental growth is not a functional correlate of sexual development. Indeed, there is a suggestion that sex precocity may be to a slight degree negatively correlated with mental growth. The precise relationship can not be definitely determined until many more cases have been given intelligence tests before and after the onset of precocious sexual maturity. In the meantime, we are now certain that Crampton's views regarding the mental significance of pubescence are greatly exaggerated and even erroneous, when tested out against evidence provided by the rare instances of puberty praecox.

5. Dentition as an Index of Anatomical Age

Attention was focused at an early date, by the work of Crampton, Beik, and Bean, upon dentition as an index of physiological and anatomical development. Crampton, as mentioned in the preceding section, regarded eruption of teeth as a very important index of physiological development. In the concluding section of his papers in the American Physical Education Review, he presented data on dentition and asserted a marked correlation between stage of teeth eruption and age, height, and weight. However, no evidence concerning dentition and scholarship or intelligence was given. Beik, after reviewing available literature, holds that dentition is the best single indicator of the stage of physical development. He concludes that "requirements for entrance to school based on stage of progress in physiological development or physiological age would be far superior to a requirement taking account of chronological age only."[25] It is strange, in view of such a definite conclusion, that no evidence of any close relation between stage of dentition and intelligence is given. Bean, on the basis of original data gathered in the course of examining every available school child in Ann Arbor, Michigan, in addition to 776 Filipino children in Manila, presents a table showing the average age of eruption of each tooth. This table provides a set of standards or norms whereby any given child may be classified according to his stage of dentition as an index of his physical development.[26] Bean urges the value of this sort of standard in claiming, "The teeth are more convenient and more exact as a means of determining the physiological standard than stature, or weight, or the growth of the bones, or secondary sexual characters, etc., and they may be of greater value than any other means that can be utilized." He further asserts belief in a considerable correlation of mental and dental development, citing as evidence that, "at each age from 7 to 14, children who are pedagogically retarded have an average of 0.9 of a tooth less and children who are pedagogically accelerated have an average of 0.8 of a tooth more than those making normal progress in school." We are again faced with averages only, hence it is impossible to determine the degree of relationship inherent in the data.

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[25] Arthur K. Beik, "Physiological Age and School Entrance," *Ped. Sem.*, 1913, 20:277-321.

[26] R. B. Bean, "The Eruption of the Teeth as a Physiological Standard for Testing Development," *Ped. Sem.*, 1914, 21:596-614.

The work of Lowell and Woodrow in 1922 suggested for the first time that the correlation between number of teeth and I.Q., for constant chronological age, was negligible. (See Table 25.) Abernethy, in 1925, computed the coefficient of correlation between dentition and Stanford-Binet mental age for 120 elementary school girls under 13 years of age and found the partial correlation (chronological age held constant) to be slightly negative (— .12 ± .06).[27] But Perkins, a year later, on the basis of partial correlations, asserts a close assocation to exist between dentition and mental age.[28] These data illustrate again the pitfalls of partial correlation. At least, our surmise is that the difficulty may inhere in the partial correlation technique, although certain facts in her published report suggest the possibility that an unfortunate computational error may have been involved.

As subjects, Perkins employed 555 elementary school pupils in Chicago, ranging in age from five to eighteen, referred to the department of Child Study for psychological examination because of school maladjustment. Each child was given the Stanford-Binet test, the resulting mental ages ranging from 2 years 6 months to 15 years. The measure of dentition utilized was the total number of permanent teeth erupted. The partial correlation between M.A. and Number of Teeth (with C.A. constant) is reported as being + .47! Such a finding is so striking as to warrant every reasonable effort to analyze its significance. The writer has recomputed this partial coefficient of correlation and finds no error in its original computation. Perhaps the clue is to be found in the zero order coefficients of correlation which are reported as follows:

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[27] E. M. Abernethy, "Correlations in Physical and Mental Growth," *J. of Educ. Psychol.*, 1925, 16:458-466 and 539-546.

[28] Frances J. Perkins, "Relation of Dentition to Mental Age," *Ped. Sem.*, 1926, 33:387-398.

Notation: 1 = Number of Teeth; 2 = Mental Age; 3 = Chronological Age.

$$r_{12} = +.71$$
$$r_{13} = +.91$$
$$r_{23} = +.61$$

At once we are struck by the relatively low correlation of $+.61$ between M.A. and C.A. For such a heterogeneous group of children, chronologically and mentally, we would expect a much higher correlation. As a matter of fact, reported coefficients of correlation between M.A. and C.A. for the age range covered in this study have usually been at least $+.80$. Let us assume, for the moment, that some computational error was actually involved and that r should have been reported as $+.80$. Assuming the other zero order correlations to be correct and substituting the assumed r of $+.80$ in the partial correlation formula, we obtain a partial correlation between M.A. and Dentition (with C.A. constant) of $-.07$. This would be more nearly in line with Abernethy's result.

That some such error has entered into the statistical analysis of Perkins' data seems probable in view of the absence of any marked differences between the median number of teeth erupted for each chronological age group classified according to I.Q. These data are given in a table in her report and are reproduced here, in Table 30. Figure 8, constructed from these data, shows at a glance that the three highest I.Q. groups are indistinguishable on the basis of dentition. The lowest I.Q. group shows a slight deficiency in erupted teeth. However, it must be remembered that this slight deficiency itself is discernible only as a difference in central tendency. Furthermore, after age 10, the difference is negligible, and in five age groups it is actually in favor of the lowest I.Q. group as compared with one of the other I.Q. groups. (See Table 30.) Since no measures of variability

TABLE 30

Showing Median Number of Teeth According to C.A. for Each of Four I.Q. Groups. (After Perkins.)

	I.Q. 21 TO 69		I.Q. 70 TO 79		I.Q. 80 TO 89		I.Q. 90 TO 121		
C.A.	*N.*	*Median No. of Teeth*	*N.*	*Median No. of Teeth*	*N.*	*Median No. of Teeth*	*N.*	*Median No. of Teeth*	*Total N.*
5	2	5.0	3	0.5			1		6
6	10	5.0	11	6.4	6	6.5	19	5.7	46
7	8	7.5	14	10.2	13	9.5	28	10.2	63
8	18	10.3	16	11.0	31	11.3	29	12.1	94
9	16	12.5	22	14.3	24	16.3	11	14.2	73
10	18	15.5	20	20.0	22	20.3	13	21.2	73
11	18	24.5	27	22.4	10	25.3	7	24.5	62
12	17	25.5	8	26.0	9	26.5	4	27.5	38
13	28	26.4	16	27.7	3	28.2	3	25.2	50
14	18	27.6	8	25.5	2	28.0	6	27.0	34
15	9	28.1	0		5	27.5	0		14
16	1		0		0		0		1
17	0		0		1		0		1
Total	163		145		126		121		555

are included in the report, it is impossible to fully evaluate the obtained differences.

In view of the large number of cases involved, it is unfortunate that a series of correlations between M.A. and number of teeth were not computed for each separate chronological age group. On the basis of the averages shown in Table 30 it is apparent that the correlation would be close to zero for each age beyond the tenth year and that it would be positive but low for each of the ages below ten. For these reasons we must conclude that this study is in harmony with all other available evidence pointing to the existence of only a negligible correlation between dentition and mental age.

The Harvard growth study included dentition as one of the important aspects of development to be studied, and we are indebted to Psyche Cattell for a most painstaking

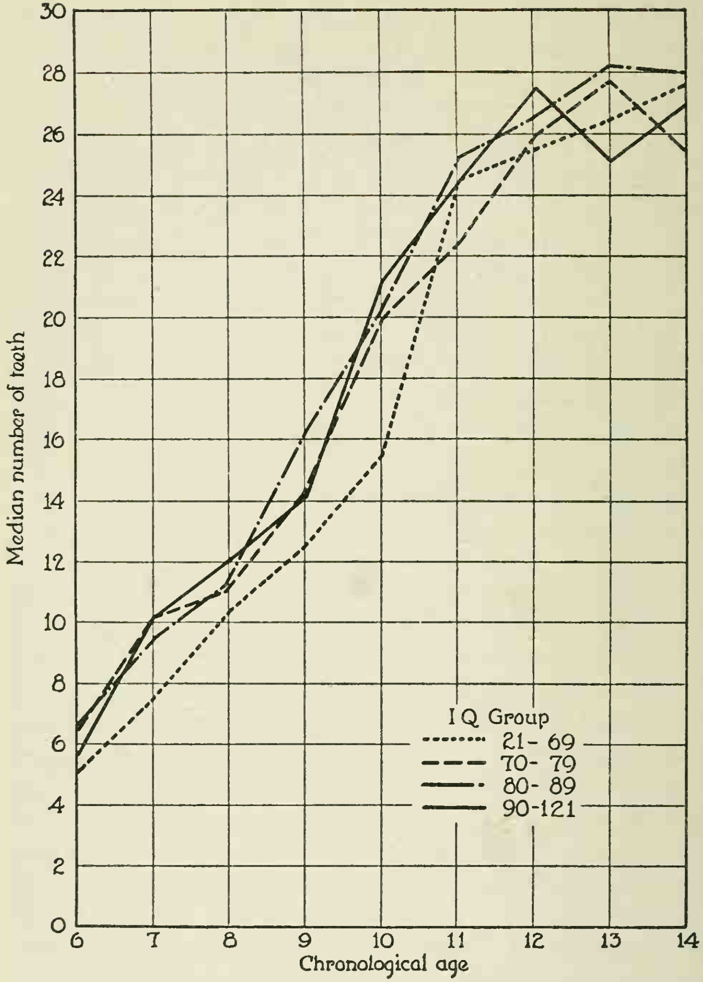

Fig. 8.

Curves showing median number of teeth at each age from 6 to 14 for each of four I.Q. groups. (Based on data of Perkins.)

and competent monograph on this phase of growth.[29] With respect to the relation between dentition and intelligence her findings are negative. This is shown by comparative studies between bright and dull groups and by direct correlation for various homogeneous age groups.

The comparative method employed utilized 606 examinations on feeble-minded boys and 274 examinations on feeble-minded girls confined in the Walter E. Fernald State School for the Feeble-minded; 338 examinations on dull boys and 268 on dull girls (I.Q.'s below 90); 8377 examinations on a random sample or unselected group of school boys and girls (I.Q.'s exhibiting the total range to be expected in a random sample); and 710 examinations on superior boys and 639 made on superior girls (I.Q.'s above 110). In all four groups, only individuals of North European descent are included, hence the important factor of race is effectively controlled.

The main results are shown in Figure 9 for boys and in Figure 10 for girls. It is apparent that the curves for these four contrasting mentality groups are so similar as to justify the conclusion that dental development and mental development are practically unrelated.

The major results from the correlational method are shown in Table 31. Sex and age are experimentally controlled. All of the coefficients are low but positive, ranging from + .05 to + .12. As Cattell points out, even this amount of correlation may be spurious in part, since each age group covers a span of 12 months during which time dental development and mental growth proceed abreast, resulting in the appearance of a degree of association which in reality does not exist. When age differences within the one year

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[29] Psyche Cattell, "Dentition as a Measure of Maturity," Harvard Monographs in Education, No. 9 (Harvard University Press, Cambridge, 1928), pp. 1-91.

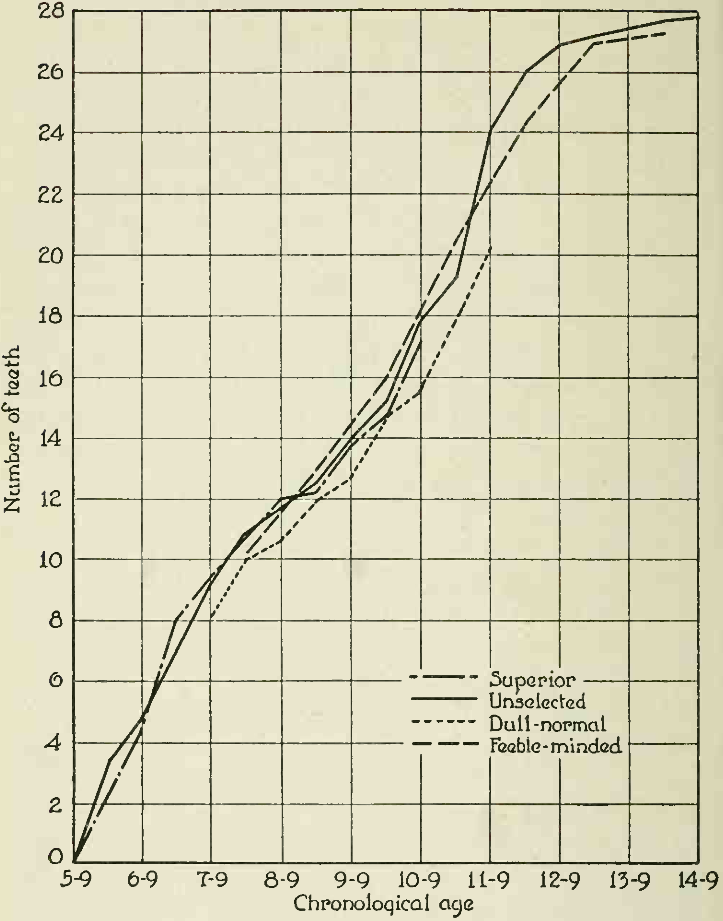

FIG. 9.

Curves showing the median number of permanent teeth at each age from 5 to 15 for boys classified into four levels of intelligence. (Reproduced by permission from Cattell, Harvard Monog. in Educ., No. 9, p. 79.)

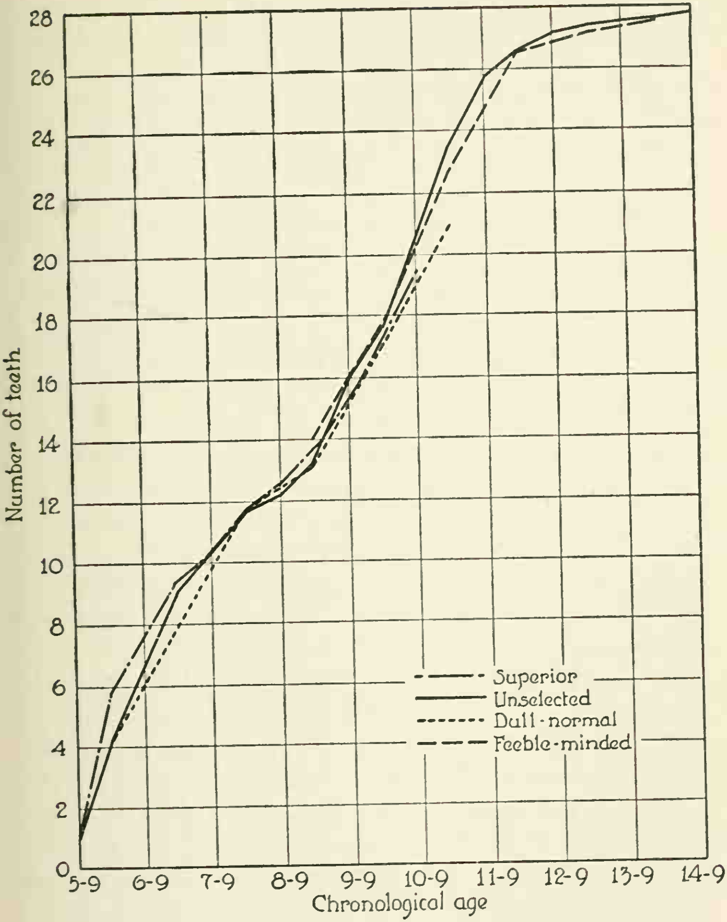

Fig. 10.

Curves showing the median number of permanent teeth at each age from 5 to 15 for girls classified into four levels of intelligence. (Reproduced by permission from Cattell, Harvard Monog. in Educ. No. 9, p. 80.)

TABLE 31

Coefficients of Correlation Between Dentition and Mental Age for Unselected American School Children of North European Descent. (After P. Cattell.)

No. of Cases	*Age Range*	*Sex*	*r*	*P.E.*
55	6 yrs. 3 mos. to 7 yrs. 3 mos.	boys	.12	.09
47	6 yrs. 3 mos. to 7 yrs. 3 mos.	girls	.12	.09
100	8 yrs. 0 mos. to 8 yrs. 11 mos.	boys	.05	.07
100	8 yrs. 0 mos. to 8 yrs. 11 mos.	girls	.05	.07
100	10 yrs. 0 mos. to 10 yrs. 11 mos.	boys	.11	.07
100	10 yrs. 0 mos. to 10 yrs. 11 mos.	girls	.09	.07
500	5 yrs. 6 mos. to 11 yrs. 5 mos.	boys	.11 *	..

* This is the correlation between Dentition and Mental Age when chronological age was rendered constant by means of the partial correlation formula.

range are held constant by partial correlation all of the coefficients of correlation between number of teeth and mental age are reduced by about .05. If this technique be accepted as valid it would appear that the true correlation between dentition and mental age for constant chronological age is very low indeed. The correlations would range from .00 to + .07.

In view of the consistency with which the quantitative data fail to substantiate the original claims of Crampton and others regarding the mental significance of dentition we are justified at this time in concluding that dental development and mental growth are shown to be relatively independent.

6. Summary

Our notions regarding the relation between various aspects of physical growth and mental development have undergone a radical change during the past twenty years. At the outset, many workers asserted and attempted to prove that mental development is dependent upon physical development. In addition to time-honored height and weight measurements, proposals for measuring physical maturity in terms of anatomical age (stage of ossification of wrist bones made possible by the introduction of Roentgen-Ray photography), physiological age (stage of sexual maturity), and dental age (eruption of permanent teeth) were put forth with the definite claim that each of these "physical ages" would be found to be closely correlated with mental age.

The "pure science" aim of establishing a physical basis for intellectual development was accompanied by emphasis upon the pedagogical applications of such asserted relationships. Proposals for the educational classification of school children, determination of the school load to be carried by a given child, and aid in selecting those to be promoted to a next higher grade, were made utilizing physical status in addition to chronological age and mental age. Also, rather pointed suggestions regarding the interpretation of the significance of mental age were made. They were tantamount to a declaration that relative mental status was to be determined by the ratio of mental age to physical age rather than by the customary ratio of mental to chronological age. The literature of this period (1910 to 1920 roughly) may be characterized as extremely optimistic as to the possibility of ushering in a new era of scientific educational guidance upon a foundation of physical measurements. Even as late as 1924, we find this sort of emphasis within educational circles. We may summon Pechstein and McGregor as witnesses in view of the fact that they then stated: "Mental growth correlates strikingly with physical and physiological growth; superiority in intelligence is due in part to greater native capacity and a greater anatomical and correspondingly physiological development" (p. 41).[30] Furthermore, with reference to pedagogical application, they state, "physiological development should be considered regularly in grade placement, and especially in cases of question, for example, failure or double promotion" (p. 45).

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[30] L. A. Pechstein and A. L. McGregor, *Psychology of the Junior High School* (Houghton Mifflin Co., Boston, 1924).

But extensive experimentation within the past ten years has served to dissipate the exaggerated notions entertained by the earlier writers in this field. Our critical analysis of available research studies may be summarized as follows:

1. There is a low positive correlation between anatomical age and mental age for constant chronological age.
2. There is little or no correlation between mental development and pubescence.
3. Apparently, there is a slight negative correlation between sexual precocity and mental capacity. Cases of puberty praecox show no tendency for any spurt in mental development to accompany the early and sudden onset of puberty.
4. Dental development and mental growth are relatively independent.
5. Various aspects of physical growth are shown to be far from unitary. Therefore, no one phase of physical status is an adequate index of physical maturity.

The above conclusions are in direct opposition to the views of those who hold that mind and body are so intimately interrelated that every aspect of mind and every feature of the body must be regarded as part of a functional unity. Such a view is shown on the basis of empirical, quantitative investigation to be false. For this reason, we can not look to structural and physiological aspects of development, such as height, weight, ossification ratio, pubescence, or dentition, for an explanation of the tremendous range of individual differences in intellect found among any random group of individuals even though they are homogeneous in age, sex, race, nationality, and educational opportunity. This being true, it is obvious that assertions regarding the pedagogical significance of normal variations in physical status must be heavily discounted. Indeed, this conclusion is ungrudgingly accepted in the 1929 revision of Terman's *The Hygiene of the School Child,* when the authors state that the original chapter on "The Significance of Physiological Age" has been dropped because of its doubtful pedagogical significance.[31]

In conclusion and on the basis of available evidence, we may say that height, weight, size and shape of head, anatomical development, pubescence, and dentition do not provide us with a physical basis of intellect. The search for such a physical basis must be carried on in other directions.

[31] L. M. Terman and J. C. Almack, *The Hygiene of the School Child,* Rev. Ed. (Houghton Mifflin Co., Boston, 1929), pp. 1-505.

Chapter V

MORPHOLOGIC INDEX, HEIGHT-WEIGHT RATIO, AND INTELLIGENCE

"HOPE springs eternal in the human breast" within as well as beyond the scientific pale. Defeated in the search for high positive correlations between intelligence and such physical traits as height, weight, or head measurements the scene of battle is shifted not to a simpler but to a more elaborate stage in which complicated morphological indices are featured with renewed confidence by their sponsors that these will at last prove to be the elusive and yet indisputably existent physical basis for intellect.

1. The Morphological Theories of S. Naccarati

The late Dr. Naccarati, after having attempted to explain away all previous conflicting results by saying that intelligence is "a most complex trait" and therefore no simple, single physical trait could be expected on *a priori* grounds to correlate closely with intelligence, advanced a morphologic index theory.[1] In reviewing the trend of conflicting results he stated:

"It is obvious that none of the anthropologic traits alone could solve the problem of correlation with intelligence. As I said above, intelligence is a most complex trait, therefore, I believe that any physical trait in order to be a correlative of intelligence must be a compound one, namely, it must be made up of many elementary traits" (p. 3).

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[1] S. Naccarati, "Morphologic Aspect of Intelligence," *Arch. of Psychol.*, no. 45, August, 1921.

He set out to explore the possible dependence of intellect upon morphologic type adopting the following classification; (patterned after Viola):

> "*Microsplanchnics* are individuals possessing a small trunk so that the development of the limbs is in excess over it, that is the vertical diameters predominate over the horizontal diameters in the body as a whole and in its constituents, trunk, extremities, and portions of the extremities.
>
> *Macrosplanchnics* or *megalosplanchnics* are individuals possessing a large trunk which is excessively developed in comparison with the limbs; that is the horizontal diameters are prominent in comparison with the vertical diameters in the body as a whole and in its constituents, trunk, extremities and portions of the extremities.
>
> Between these two opposite types are the *normosplanchnics* who represent individuals in which trunk and limbs show a harmonious development."

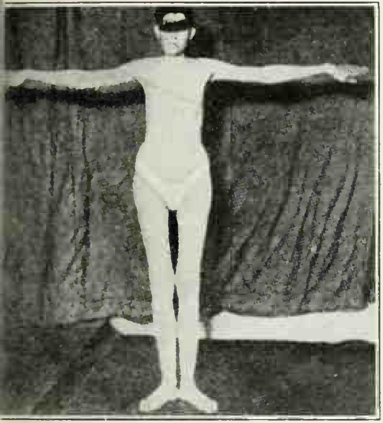
The two extreme types (microsplanchnic and macrosplanchnic) are illustrated in the accompanying photographs. The reader, familiar with Kretschmer's physical types (see Chapter VII) will recognize that the first picture illustrates equally well the asthenic type and the second the pyknic type.

Naccarati had observed that bright children during the period of growth tended toward microsplanchny in contrast to less bright or dull children, and thereupon he undertook to demonstrate his theory that *microsplanchny* is associated with brightness whereas *macrosplanchny* is associated with dullness. For this purpose he made anthropometric measurements by determining the ratio of length of the limbs (one upper and one lower limb) to volume of the trunk. This ratio he named *morphologic index*. He proceeded to correlate these indices with intelligence test scores for various groups of college students. In most of his work, however, he utilized a simpler index involving the ratio of height to weight, justifying this procedure by demonstrating for two groups of students that this index correlates + .70 or more with the more elaborate ratio of length of limbs to trunk volume.

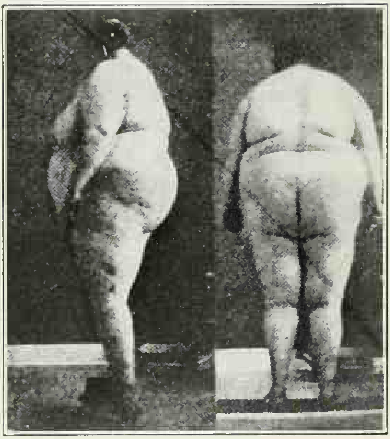
The basis for the assumption, or fact, that microsplanchnics are more intelligent than macrosplanchnics was declared by him to lie in three physiological principles. There is a relative independence in the growth of the nutritional or vegetative system and the animal system (nervous systems, muscles, and skeleton), the microsplanchnic developing relatively more in the latter respect and the macrosplanchnic more in the former. The microsplanchnic represents physical hyperevolution and presumably mental hyperevolution as well. Finally, the microsplanchnics correspond to the hyperthyroid types.

Believing, as he did, that some of the hormones which regulate the morphology of the body during the period of growth also influence the development of mentality it is easy to see how Naccarati came to place great stress upon morphologic type as the physical basis for intelligence. However, he did exclude pathological cases (ultramicrosplanchnics would not be expected to possess superior intelligence), and hastens to admit that some macrosplanchnics can be intelligent. His theory, then, holds that, in general, microsplanchnic individuals in a given group will tend to be superior to macrosplanchnics in intelligence. The exact amount of relationship constitutes the problem for research.

In a series of papers thirteen coefficients of correlation between the Ht-Wt Index and Intelligence Tests Scores and one coefficient between his elaborate Morphological Index and Intelligence Scores are reported, all the work being confined to various groups of students, both men and women, at



Iicrosplanchnic physical type as
escribed by Naccarati. Repro-
uced by permission from Engel-
ach, Med. Clin. of No. Am. 1922,
p. 14



Macrosplanchnic physical type as described by Naccarati. Reproduced by permission from Engelbach Med. Clin. of No. Am. 1922, p. 22

TABLE 32

Summary of S. Naccarati's Reported Coefficients of Correlation Between the Height-Weight Index and Intelligence and Between the Morphologic Index and Intelligence. Note: In each investigation college students were used as subjects.

					COEFFICIENT OF CORRELATION BETWEEN INTELLIGENCE AND:—	
Author	*Date of Publication*	*Sex of Subjects*	*No. of Cases*	*Criterion of Mental Ability*	*Ratio Ht : Wt*	*Ratio Limbs : Trunk*
S.N.	1921	?	75	Thorndike Test	.16 ± .08	.35 ± .07
S.N.	1921	?	221	Thorndike Test	.23 ± .04	
S.N.	1921	?	80	Thorndike Test	.27 ± .07	
S.N.	1921	?	100	Thorndike Test	.33 ± .06	
S.N. + R.L.L. + G.	1922	Mostly F	50	Army Alpha	.44 ± .06	
S.N. + R.L.L. + G.	1922	M & F	94	Otis Test	.15 ± .07	
S.N. + R.L.L. + G.	1922	M	252	Thorndike Test	.13 ± .04	
S.N. + H.E.G.	1923	M	57	Army Alpha	.31 ± .08	
S.N. + H.E.G.	1923	M	57	4 tests of Controlled Assoc.	.44 ± .08	
S.N. + H.E.G.	1923	M & F	150	4 tests of Controlled Assoc.	.24 ± .05	
S.N. + H.E.G.	1923	M	50	4 tests of Controlled Assoc.	.17 ± .09	
S.N. + H.E.G.	1923	F	50	4 tests of Controlled Assoc.	.11 ± .09	

Columbia University.[2] These coefficients of correlation have been brought together in Table 32 to permit ready comparison. A glance at the column containing the coefficients of correlation reveals a striking diversity in their magnitude, ranging as they do from + .11 ± .09 to + .44 ± .08. It so happens that these two extremes are found in the same investigation. The average of all 13 coefficients is + .256, a value which would indicate a more definite relationship between morphologic index and intelligence than any hitherto reported coefficients of correlation between a single aspect of physical development (such as height, weight, ossification ratio, dentition, or pubescence) and intelligence. However, the variability of these correlations from one investigation to another and even within the same investigation should make us very cautious in accepting the results as a whole as definitely establishing a relationship of +.256. *For the most part, the high correlations emerge from studies based on an uncomfortably small number of cases.* In only six of the correlations reported do we find the P. E. sufficiently small to warrant acceptance of the coefficients as being statistically reliable. Furthermore, the validity of correlations derived from experimental groups composed of both men and women is doubtful to say the least. Plain scientific caution requires suspended judgment pending further evidence.

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[2] S. Naccarati: "The Morphologic Aspect of Intelligence," *Arch. of Psychol.*, no. 45, 1921, pp. 1-44; S. Naccarati and R. L. Lewy-Guinzburg, "Hormones and Intelligence," *J. of Appl. Psychol.*, 1922, 6:221-234; S.

2. Attempts to Verify Naccarati's Theories

In 1923, Stalnaker reported correlations of +.18 ±.05 for 150 high school sophomores and +.13 ±.09 for 47 college students.[3] The physical index used is only roughly com-

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Naccarati and H. E. Garrett; "The Influence of Constitutional Factors on Behavior," *J. of Exper. Psychol.*, 1923, 6:455-465; S. Naccarati and H. E. Garrett, "The Relation of Morphology to Temperament," *J. of Abnorm. and Soc. Psychol.*, 1924-25, 19:254-263; S. Naccarati, "The Morphologic Basis of the Psychoneuroses," *Am. J. Psychiatry,* 1924, 3:527-545.

[3] Elizabeth M. Stalnaker, "A Comparison of Certain Mental and Physical Measurements of School Children and College Students," *J. of Comp. Psychol.,* 1923, 3:181-239, 431-469.

parable to Naccarati's Ht-Wt index, since she computed for each individual a Wt-Ht index and then determined the per cent. which this index is above or below the normal as given in Wood's tables. Her coefficients of course came out with a negative sign but must be interpreted as positive to bring them in line with Naccarati's. It is to be noted that these two reported coefficients are low and, furthermore, the P.E.'s do not give them complete reliability.

Buford Johnson's study of physical and mental growth carried on in the City and Country School and in affiliation with the Bureau of Educational Experiments in New York City demonstrated the existence of only a slight correlation between the Wt-Ht index in the case of children age two to age thirteen.[4] For 191 children the coefficient of correlation between Stanford-Binet Mental Age and the Wt-Ht index was found to be +.68 ±.02. It must be remembered, however, that both Wt-Ht index and Mental Age are positively correlated with chronological age, hence the crucial test of the relation between the physical index and the mental index can be applied only when the factor of chronological age is kept constant. When this is done by partial correlation technique, the correlation between the Wt-Ht index and M.A. with C.A. held constant turns out to be negligible, namely +.04 ±.05.

The work of Heidbreder is the most significant and important available on this subject.[5] Not only are her results impressive because they are based on 1,000 white, native born students, but also her results are adequately controlled as regards sex, reliability and validity of intelligence tests used, care with which the physical measurements of height and weight were taken, and mental and morphological heterogeneity of subjects as compared with those measured by Naccarati. The last fact would lead to the expectation of higher correlations than Naccarati secured, an expectation which Naccarati himself suggested in anticipation in commenting upon the homogeneous character of his subjects mentally and morphologically. But the actual correlations approximate zero: r between H/W Ratio and Final Score on the Minnesota College Ability Tests for 500 Freshman Men = +.03 ±.03, for 500 Freshman Women = +.04±.03. Not only do the correlations for the Final Score approximate zero but correlations between each of the five mental tests included in the test battery and the H/W Ratio likewise approximate zero, ranging from −.07 ±.03 to +.10 ±.03. Of these ten sub-test correlations eight are positive and only two are negative, indicating the existence of a slight, positive correlation between the height-weight ratio and intelligence.

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[4] Buford J. Johnson, *Mental Growth of Children in Relation to the Rate of Growth in Bodily Development* (E. P. Dutton and Company, New York, 1925), pp. 1-160.

[5] Edna Heidbreder, "Intelligence and the Height-Weight Ratio," *J. of App. Psychol.*, 1926, 10:52-62.

Naccarati's original contention that his elaborate morphological index should be utilized if the best possible evidence for the correctness of his theories was to be secured led Sheldon to undertake to duplicate Naccarati's elaborate procedures *in toto*.[6] Sheldon's work was done at the University of Chicago utilizing 434 freshman men, aged 17 to 22 of the white race only. Twelve physical measurements were meticulously made on each freshman following Naccarati's procedure. Using the American Council on Education 1924 Psychological Examination for College Freshmen as an adequate criterion of intelligence he obtained a coefficient of correlation of +.14 ±.03 between the intelligence test rating and morphological index. There are nine sub-tests in the 1924 American Council Tests and when the scores in each of these were correlated with the morphological indices, the r's ranged from —.02 to +.12. Again the trend is toward a definite, though very slight, positive correlation. Using fall term grade points as a criterion of mental ability, r between scholarship and morphological index is +.11 ±.03.

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[6] William H. Sheldon, "Morphologic Types and Mental Ability," *J. of Personnel Research*, 1927, 5:447-451.

A final test of Naccarati's theory may be found in the recent work of his one-time co-worker, H. E. Garrett, collaborating with Kellogg.[7] In this study, all measurements entering into the morphological index were taken from photographs of their subjects. These photographs had been taken by the gymnasium authorities under uniform conditions, a front, a rear, and a side view of each freshman in the nude. To justify their procedure, the authors report that the coefficient of correlation between morphologic index and the height-weight ratio (obtained from actual measurements) for 219 men was +.81 ±.02. Correlations obtained by Naccarati's morphologic index and height-weight ratio as previously reported were +.70 or more. Garrett and Kellogg also point out that the correlation between the unconverted picture-heights and the gymnasium measurements of the stature of these same 217 men was +.98 ±.002. The Thorndike Psychological Examination for High School Seniors and College Freshmen provided the criterion of mental ability. For 206 cases the coefficient of correlation between the "picture morphological index" and Thorndike test ratings turns out to be +.07 ±.05, whereas the r between the actual height-weight ratio and Thorndike test ratings is only +.10 ±.05.

In view of the consistency with which low, positive correlations between the height-weight ratio or morphological index and intelligence test results have been secured by Naccarati and his successors we would be justified in concluding that his elaborate theories in support of an intimate relation between hormones, bodily development, and intelligence fail to be substantiated by thoroughgoing scientific attempts at verification. Naccarati's hope and belief that a "compound physical trait" must surely show decided correlation with such a complex trait as intelligence must now be relegated to science's scrap-pile for abandoned hypotheses.

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[7] H. E. Garrett and W. N. Kellogg, "The Relation of Physical Constitution to General Intelligence, Social Intelligence, and Emotional Stability," *J. of Exper. Psychol.*, 1928, 11:113-129.

3. Additional Evidence on Body Build and Intelligence

One of the main objectives of Sommerville's researches on the relation of physical traits to intelligence was to find an index of body build which would yield significant correlations with intelligence and academic success.[8] As subjects, he used slightly more than 100 students in Columbia College. The Thorndike three hour Intelligence Test for High School seniors was used as the criterion of intelligence. A host of body dimensions were used singly and in combination to yield various indices of body build.

Arm length plus leg length divided by sitting height was used as an approximation to Naccarati's morphological index. This correlated to the extent of —.03 with intelligence test scores. Davenport's index $\left(1000 \times \frac{\text{Wt}}{\text{Ht}^2}\right)$ correlated —.04 with intelligence. One of Bardeen's ratios

$$\left(100 \times \frac{\text{Sitting Height}}{\text{Height}}\right)$$

correlated —.02 and another of Bardeen's ratios

$$\left(\frac{100{,}000 \times \text{Wt}}{\text{Ht}^3}\right)$$

correlated —.09 with intelligence. Pignet's index (Height — Chest Girth + Weight) correlated —.06. In brief, none of these complicated indices of body build was found to yield significant correlations with intelligence test measurements.

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[8] R. C. Sommerville, "Physical, Motor, and Sensory Traits," *Arch. of Psychol.*, vol. 12, 1924, pp. 1-108.

Similarly, all simple measurements of physical traits such as height, weight, chest girth, head diameters, face length, nose length, etc., yielded low correlations with intelligence. Twenty-one of thirty such correlations ranged between —.10 and +.10. The P.E.'s of these correlations are in the neighborhood of .06 and .07. Hence, not one of the physical measures and, moreover, not one of the physical index combinations, yielded significantly positive correlations with intelligence.

4. Summary

Just as with height or weight, and also with anatomical or physiological age, so with morphological index the experimental evidence now available warrants the belief that physical status and mental status are largely independent of one another, although there is a sufficient degree of association between the two to justify Thorndike's earlier generalization regarding the positive interrelation of all desirable human traits, mental or physical. Speaking of men in the mass, there is a definite, though slight, correlation between physical development and mental development. From the point of view of man, the individual, the relation between physical characters and intellectual traits is so slight as to make it quite impossible in any given case to predict mental status when physical status is known, or vice versa.

Chapter VI

PHYSICAL CONDITION AND MENTAL EFFICIENCY

EVEN though the trend of evidence does not reveal intimate interrelation of physical and mental development, surely it might be supposed, physiological malfunctioning should promptly reflect itself in reduced mental efficiency. It would seem almost axiomatic that physiological impairment has a deleterious effect upon the intellect. Any investigation of the effect on mental functioning of such conditions as malnutrition, adenoids and diseased tonsils, enlarged glands (simple goitre for example), dental caries and impacted teeth, or hookworm would naturally be undertaken with the object of determining not whether such physical conditions do affect intellect but rather how extensive is the havoc wrought by these undesirable and pernicious influences.

The negative results reported by Heron, however, who used the elaborate biometric methods of the Galton-Pearson school suffice to establish an initial presupposition that the trend of available evidence lies in the direction of reversing common sense notions on this subject.[1] Dealing with 4,286 boys and 4,474 girls in an extensive investigation covering a dozen different schools, he reports numerous correlation coefficients between intelligence as estimated by school teachers

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[1] David Heron, *The Influence of Defective Physique and Unfavorable Home Environment on the Intelligence of School Children* (Cambridge University Press, 1910).

TABLE 33

Summary Showing Mean Coefficients of Correlation between Teachers' Estimates of Intelligence and Various Physical Traits. (Heron, Cambridge Univ. Press, 1910.)

	MEAN OF PARTIAL COEFFICIENTS OF CORRELATION FOR CONSTANT AGE	
Characters	*Boys*	*Girls*
Mental capacity and Height...............	.10	.07
" " " Weight	.06	.03
" " " Condition of Teeth....	.08	.09
" " " Nutrition Status	.01	.08
" " " Cervical Glands	.09	.08
" " " Tonsils and Adenoids..	—.01	.11

and physical conditions as revealed by medical examiners. Table 33 summarizes the results obtained by giving the mean partial coefficients of correlation with chronological age held constant. It will be noted that his results for height and weight are in harmony with our systematic and critical synthesis of available evidence.

The most recent report issued by the Galton-Pearson laboratory is also in harmony with the earlier results secured by Heron.[2] Negligible correlation was found between intelligence and general factors of health (nutrition, and anaemia as shown by color of face and haemoglobin percentage), for 1496 alien Jewish children. The same investigation also revealed negligible correlation between intelligence and certain pathological characters such as condition of cervical glands, tonsils, and ears, nose breathing versus mouth breathing, signs of tuberculosis, heart trouble, and defective teeth. With reference to the whole study, the authors state:

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[2] Karl Pearson and Margaret Moul. "On the Intelligence of the Alien Jewish Children," *Annals of Eugenics*, 1925-26, 1:56-127.

"For the practical purposes of prognosis there does not exist in the present material any correlation of the slightest consequence between the intelligence of the child and its physique, its health, its parents' care or the economic and sanitary condition of the home" (p. 124).

We must now inquire whether the results obtained by Pearson and Moul and by David Heron for various physical defects are confirmed by the body of the scientific studies made to date.

1. The Mental Effects of Malnutrition

The prevailing view, until quite recently, may be summed up in the words of Terman who wrote in 1913: "The effect of malnutrition on mental development is probably very great, though difficult to measure accurately."[3] Similar views could be quoted in abundance, particularly from those who seem to feel that a health program should justify itself in terms of mental improvement over and above demonstrable gains in physical condition and well-being.

As a matter of fact, having uncovered negative results with respect to height, weight, and the height-weight ratio, only a moment's reflection should lead us to expect that malnutrition has only minimal effect in dulling mental operations because malnutrition itself is a condition diagnosed on the basis of percentage deficiency in height and weight in relation to available age norms. Indeed, in Chapter V, we presented Stalnaker's negative results from experiments designed to determine the relation between physical indices of nutritional status and mental development. Similar negative results were presented in Chapter IV in connection with the comprehensive investigation undertaken by Gates and his students. If the reader will refer back to Table 28, it will be noted that nutritional status correlated negligibly with mental age and the other maturity ratings, although it does produce the highest correlation coefficient in the table, namely, an r of +.37 with teachers' estimates of physical vigor and stamina.

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[3] L. M. Terman, *The Hygiene of the School Child* (Houghton Mifflin Company, Boston), 1914, p. 99.

A brief review of additional investigations directly aimed to ascertain the relation of malnutrition to intelligence will round out discussion of this problem.

In an intensive experiment concerning the rôle of the "nutrition class" in health education, the Bureau of Educational Experiments in New York City inaugurated classes so designated in February 1918 and continued them until June, 1921.[4] Although the experiment failed to control satisfactorily economic status and racial or stock differences the available evidence indicates that the experimental group which was organized solely on the basis of percentages underweight differed from the control group in general intelligence (I.Q.) in no essential respect. In fact, the undernourished children yielded an average I.Q. somewhat higher than the control group but the difference was less than the size of the probable error of the difference. Thirty-seven undernourished children ranged from 64 to 126, whereas the I.Q.'s of the control group ranged from 55 to 125. As regards physical benefits derived from the health procedures it would seem that children of high intelligence gained more physically than did those of lower intelligence. In conclusion, it is stated: "Aside from extreme cases of malnutrition, of prolonged hunger or starvation which like other pathological states would cause disintegration, we cannot say that malnutrition irrespective of other factors produces or runs hand in hand with mental defectiveness. In many types of mental processes the reactions of the undernourished child are equal or superior to the average of his age group. The traits in which he may prove less capable seem to be resistance to fatigue under response to uninterrupted or complex stimuli, and exaggerated emotional responses under normal stimulation."

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[4] J. L. Hunt, B. J. Johnson, E. M. Lincoln, *Health Education and the Nutrition Class* (E. P. Dutton and Company, New York, 1921), pp. 1-281.

Similar testimony is given by Dowd who reports the results of intelligence tests given to 55 undernourished children in the Nutrition Class at the Bellevue Children's Clinic and 55 children selected at random from the general admissions.[5] The report concludes as follows:

> "In general, our experience has agreed with other investigators that undernourished children distribute themselves in tests of intelligence similarly to normal children: that children of high general intelligence gain more under nutritional care than those of lower scores . . . and that from the small number of cases that we have been able to retest after a period of six months or more nutritional care, it would appear that the mental level is not affected, for while improvement was shown in all other respects the I.Q. remained substantially the same."

We may also mention the negative results secured by Hoefer and Hardy in connection with the three-year study of the effect of intensive health instruction on various aspects of the physical and mental growth of 343 elementary school children.[6] These children were classified as accelerated or retarded in *rate* of growth, in weight in relation to height, age, and build (index of nutritional status). The initial I.Q.'s of these two groups revealed no significant difference, the

[5] H. L. Dowd, "Relations of Mental Retardation to Nutrition," Hosp. Soc. Serv. 1922, 6:92-95.

[6] C. Hoefer and M. C. Hardy, "The Influence of Improvement in Physical Condition on Intelligence and Educational Achievement," *Twenty-seventh Yearbook of the Nat. Soc. for the Study of Education,* Part I, 1928, pp. 370-387.

mean I.Q. for the accelerated group was 104 and for the retarded group was 103. Absence of any statistically significant differences in I.Q.'s for the two groups at the end of two years indicates that normal mental development was proceeding quite irrespective of nutritional status.

Nicholls studied a group of 59 underweight children each one matched on the basis of age and intelligence with one of normal height and weight in a control group.[7] The aim of this investigation was to disclose differences in mental pattern or profile if these existed. The following tests showed no differences between the undernourished children and the control group: memory span for digits, controlled association (opposites test), numbered combinations, and continued work in numbered combinations. However, undernourished children proved to be inferior to the control group in tests of muscular strength and coördination. The onset of fatigue was more rapid and strength and endurance seemed to be definitely on a lower level in the underweight group. Of course, these differences are based on averages revealing a trend only.

If we assume that our measures of intelligence reflect the condition of the higher centers of the central nervous system, the absence of demonstrable relationship between undernourishment and mental functioning gives rise to the search for an adequate explanation of the finding. Much of the mystery disappears if we keep in mind the safeguards nature has thrown around the nervous system. Scammon has shown that even when gross malnutrition exists and physical growth is greatly retarded or even arrested still the nervous system continues to grow, apparently at the expense of the bodily tissues themselves. In view of such evidence it is little wonder that Blanton concluded, after a personal survey of a group of German school children, half of whom were supposed to have suffered from malnutrition for a period of two or three years toward the end of the World War, that "children free from organic nervous disease and with parents of average intelligence very rarely become feeble-minded through malnutrition even of an extreme degree."[8]

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[7] E. E. Nicholls, "Performances in Certain Mental Tests of Children Classified as Underweight and Normal," *J. of Comparative Psychol.*, 1923, 3:147-181.

2. The Influence of Physical Defects

Much has been written concerning physical defects and intelligence. The prevalence of physical defects among school children and more recently among drafted recruits during the World War startled everybody. The almost dramatic character of the findings certainly tended to emphasize the importance of physical defects and this perhaps accounts for assertions to the effect that such defects are associated with, if not responsible for, mental retardation.

Even recently, as competent an authority as Charles E. Spearman emphasized the old maxim, *mens sana in corpore sano* and cited results of research in harmony with the theory that physical defects are much more numerous among dull children than among bright children.[9]

Earlier investigators had set out to prove this theory as being of vital importance in the problem of school retardation. For example, Cornell, then head of the physical examination service in the public schools of Philadelphia, compared the scholastic standing of children free from physical defects with that of children possessing physical defects.[10]

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[8] S. Blanton, "Mental and Nervous Changes in the Children of the Volks-schulen of Trier, Germany, Caused by Malnutrition," *Mental Hygiene*, July, 1919.

[9] C. Spearman, *The Abilities of Man* (The Macmillan Company, New York, 1927). See ch. XXIII, "Mind and Body." pp. 393-409.

[10] W. S. Cornell, "Relation of Physical and Mental Defects in School Children," *Psychol. Clinic*, 1908, 1:231-234.

His figures for 219 children of both sexes aged six to twelve, indicate that the average scholastic grade for those free from physical defects was 75%, for those possessing physical defects was 72.6%. He isolated those suffering from adenoids and enlarged tonsils and shows that their scholastic average was 72%. Of the latter, he states, "In many, the adenoid expression was written only too plainly on their faces." But surely these figures do not indicate any close relation between physical defects and mental defect. At the most we are confronted with only a slight relationship.

The published results of Leonard P. Ayres are also representative of the earlier approach to the problem.[11] Grouping 3304 New York school children, ages ten to fourteen inclusive, into accelerated, normal, and retarded on the basis of age-grade location, he shows that dull children are physically more defective than normal or bright children. These results are reproduced in Table 34. Ayres' interpretation of these percentage comparisons is definite. "The computations established in a convincing manner the *close connection* between certain physical defects and school progress" (italics added). At the same time the author does recognize that the figures are somewhat deceptive since it was impossible to isolate for study one defect at a time. What appears is a sort of average effect for a particular defect plus all other defects which might and very likely would be present simultaneously. Social status, of course, was not controlled, and may be responsible for the appearance of correlation between physical defects and mental ability where none in reality exists. However that may be, the differences are at the most not startling. Else how account for the fact that 25%

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[11] L. P. Ayres, "The Effect of Physical Defects on School Progress," *Psychol. Clinic*, 1909, 3:71-77. Also L. P. Ayres, *Laggards in Our Schools* (Russell Sage Foundation, New York, 1909), ch. XI, "Physical Defects and School Progress," pp. 117-132.

TABLE 34

Per Cent. of Dull, Normal, and Bright Pupils Suffering from Each Sort of Defect, Ages 10 to 14 Inclusive. All Grades. (After Ayres, *Laggards in Our Schools*, p. 125.)

Defect	*Dull* *Per Cent*	*Normal* *Per Cent*	*Bright* *Per Cent*
Enlarged glands	20	13	6
Defective breathing	15	11	9
Defective teeth	42	40	34
Hypertrophied tonsils	26	19	12
Adenoids	15	10	6
Defective vision	24	25	29
Other defects	21	11	11
Number examined	407	2588	309
Defects per child	1.65	1.30	1.07
Per Cent. of children defective	75	73	68

of the dull or retarded pupils are free from all physical defects?

A much more striking relationship is reported by Sandwick in 1920.[12] He compared the physical status of 40 pupils who scored highest on the Freeman-Rugg Group Intelligence Test with the 40 who made the lowest scores. One hundred per cent. of the low score group exhibited physical defects as contrasted with 47.5% of the high score group. The average number of defects per pupil, in the low score group was 3.41, for the high score group 0.71. Sixty per cent. of the low score group had defective tonsils as against only 10 per cent of the high score group. These differences are marked, and the results even for the low score group are quite out of line with Ayres' findings for the group of over three thousand children. However, internal evidence in the research article in question justifies extreme caution against accepting the results as typical. It was written by a high school principal who seems to have been impressed with the marked improvement in test scores made by a boy after a surgical operation which remedied some rather serious physical defects. So he drew up a list of the boys making the highest scores and a list of the boys making the lowest scores, with instructions to the school nurse to secure the health card of each boy and to tabulate the defects present for each. It is no reflection upon the intellectual honesty of either school principal or nurse to suggest that the logical fallacy of "finding what you set out to find" may have operated unconsciously as this research was set up. Furthermore, the age factor was not controlled in any way. Raw scores on the intelligence tests were used, a procedure scientifically indefensible in dealing with a heterogeneous age group. Finally, the factor of social status was uncontrolled. For these reasons, we would not endorse Spearman's appraisal when he wrote of this work, "Very important, too, would seem to be the research of Sandwick." [13]

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[12] R. L. Sandwick, "Correlation of Physical Health and Mental Efficiency," *J. of Educ. Research*, 1920, 1:199-203.

A relatively unsatisfactory study of the problem based upon measurements of 515 elementary school children in Humboldt, Tennessee was reported by Mallory.[14] He relied upon physical defect data derived from examinations made by a registered nurse. The Illinois Group Test of Intelligence was applied to all grades above the second and the Holley Picture Completion Tests were used in the first and second grade. A series of objective achievement tests was also applied. Score in each test for each child was reduced to a percentage of the median for his class or grade. This method yields ambiguous mental and educational indices since the factor of age is neglected. The method of correlating the presence or absence of specific physical defects is also to be criticized (the fourfold association method yielding Q was used) since the magnitude of Q may be quite large depending upon the chance location of a relatively insignificant number of cases above or below the average of the group as a whole. Pearson's bi-serial r was also employed. This latter formula yielded an r of +.05 between a total defect score and intelligence. Q between specific defects and intelligence varied between —.25 and +.36. One peculiar result should be mentioned in passing. The several physical defects (tonsils, vision, teeth, and hearing) were found to correlate negligibly with achievement. However, one defect (nasal obstructions) was found to correlate +.80 with achievement test scores. Yet this defect correlated only +.10 with intelligence test scores. As a matter of fact for children exposed to the same educational influences, it is very doubtful whether it is justifiable to make any distinction between intelligence tests and achievement tests. Both tests may be measuring the same thing, i.e., "academic intelligence," even though different labels be applied to them.

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[13] C. Spearman, *The Abilities of Man*, p. 399.

[14] J. N. Mallory, "A Study of the Relation of Some Physical Defects to Achievement in the Elementary School," George Peabody College for Teachers' Contributions to Educ., 1922, no. 9, 1-78.

A similar study was conducted in Manitowac, Wisconsin by Westenberger.[15] Otis Group Intelligence tests and Stanford Achievement tests were given to 404 children in grades two to eight inclusive. Unusually careful physical examinations were made of each child. The children were then classified into three groups, A, freedom from physical defects; B, in urgent need of remedial medical attention; and C, suffering from lesser physical defects. Scores on the tests were tabulated by grades and within each grade by the physical defect groups A, B, and C. Statistical comparisons with reference to intelligence and achievement scores were then made between the A, B, and C groups. It is unfortunate that chronological age was not employed as the main basis of treating the data since age is unambiguous and not dependent upon school policies of grading and promoting. No clear-cut trends emerge from the many comparisons. No evidence is shown regarding any deleterious effect of total defects on intelligence or achievement. Furthermore, no intellectual benefits were noted during a period of nine months for a group of 41 children who suffered from severe physical defects which were promptly remedied by the best possible medical and surgical care.

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[15] E. J. Westenberger, "A Study of the Influence of Physical Defects upon Intelligence and Achievement," The Catholic Univ. of America; Educ. Res. Bull., November, 1927, vol. 2, no. 9, 1-53.

Along with the studies of Mallory and Westenberger, it may be well to mention the work of Stalnaker and Roller who found no definite evidence that physical defects predominate among educationally retarded children in comparison with children making normal progress in school.[16] They concluded that failing in school could not legitimately be attributed to physical defects. As a matter of fact, they found that 91 per cent. of one hundred failing children exhibited subnormal intelligence when measured by the Stanford-Binet tests.

The elaborate study of the physical and mental status of children in two Illinois counties conducted by the United States Public Health Service included a section on physical defects in relation to I.Q.[17] The detailed data are too extensive to be included here. In general, this survey indicated that the average number of physical defects per child decreased as the I.Q. increased. In other words children with I.Q.'s above 110 exhibited fewer physical defects on the average than did children with lower I.Q.'s. However, when race, nationality, and social status were controlled by selecting white boys of native parents and native grandparents there was little difference between those having I.Q.'s less than 90 and those having I.Q.'s between 90 and 110. Those having I.Q.'s above 110 had slightly fewer physical defects on the average than either of the other two groups. The significance of these findings also is reduced when we note that detailed comparisons between these I.Q. groups on the basis of each of 34 physical defects failed to reveal that any particular defect or group of defects was responsible for the observed differences in average number of defects. Ear defects stood out as the one exception to this general finding. The author's summary statement is that, "The association of physical defects with I.Q., therefore, does not seem to be of a specific character which shows up in any specific group of defects, but rather of a general nature which expresses itself in a slightly higher rate for a number of different defects" (p. 1772).

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[16] E. Stalnaker and R. D. Roller, Jr., "A Study of One Hundred Non-promoted Children," *J. of Educ. Research*, 1927, 16:265-270.

[17] G. A. Kempf and S. D. Collins, "A Study of the Relation Between Mental and Physical Status of Children in Two Counties of Illinois," U. S. Public Health Reports, vol. 44, no. 29, July 19, 1929, pp. 1743-1784.

We turn to reports on specific physical defects in relation to intelligence.

3. Adenoids and Diseased Tonsils

Infected tonsils producing a constant toxemia and adenoids producing defective breathing might well be expected to affect mental development unfavorably. Medical opinion has tended to emphasize such an influence and a position even more extreme has been taken by many laymen. Articles have appeared in medical journals as well as in popular magazines testifying to the harmful mental effects of diseased tonsils and adenoids. Such articles usually assert that a "marvelous intellectual development" or a "surprising development of both physical and mental power" follows the removal of adenoids and infected tonsils.

It is scarcely necessary to say that there is much mere opinion and very little factual evidence to support such assertions. Science demands the application of experimental studies using "control groups" and adequate statistical methods of analysis.

Terman, in 1919, reported that the gain in I.Q. for 27 children retested after an operation for tonsils or adenoids was negligible, in fact they made a gain slightly less than that made by a random sampling of children.[18] Scrutiny of the results led Terman to suggest that "adenoids and diseased tonsils may give a child an exaggerated appearance of dullness."

The most exact and comprehensive study to date is that reported by Rogers in 1922.[19] A group of 530 children for whom I.Q.'s were available in the records of a certain public school were given a physical examination by a school nurse or physician which made it possible to subdivide them into two groups, one composed of those in whom the condition of tonsils was such as to warrant medical treatment, the other composed of those in whom the tonsils were normal or so slightly defective as not to demand treatment. The I.Q. distributions of the two groups are shown in Table 35. The I.Q. distributions in terms of percentages are shown in Figure 11. The two curves are so similar as to justify the conclusion that the presence of diseased tonsils in the infected tonsil group in no way impairs their status in I.Q. Mental equality of the groups is attested by almost identical median I.Q.'s for the two groups. The diseased tonsil group is slightly more variable, but there is no such discrepancy as in the data from which Sandwick drew his conclusions.

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[18] L. M. Terman, *The Intelligence of School Children* (Houghton Mifflin Company, Boston, 1919), pp. 151-152.

[19] M. C. Rogers, "Adenoids and Diseased Tonsils, Their Effect on General Intelligence," *Arch. of Psychol.*, no. 50, 1922, pp. 1-70.

TABLE 35

Showing Distribution of I.Q.'s for Two Groups of Children, One Group Containing Those Suffering from Diseased Tonsils, the Other Group Containing Those With Normal Tonsils. (After Rogers, *Archives of Psychol.*, No. 50, p. 29.)

	DISEASED TONSIL GROUP		NORMAL TONSIL GROUP	
I.Q.	*No. of Cases*	*Per Cent of Cases*	*No. of Cases*	*Per Cent of Cases*
140–149	1	.4	0	0
130–139	2	.8	0	0
120–129	6	2.5	9	3.0
110–119	17	7.2	24	8.1
100–109	55	23.3	67	22.8
90–99	80	33.9	107	36.4
80–89	45	19.0	52	17.7
70–79	21	8.9	29	9.8
60–69	7	2.9	4	1.4
50–59	1	.4	2	.7
40–49	2	.8	0	0
Total	237	99.1	294	99.9
Median	95.3		95.6	
σ	14.4		12.2	

Rogers goes on to report a more crucial test, namely comparison of I.Q. before and after removal of diseased tonsils for 28 children. Twenty-eight children were selected as a control group, each one of whom suffered from diseased tonsils *but was not operated upon*. The children in the operated group and in the control group were retested six months later. The average gain in I.Q. for the operated group was 2.25 points, a negligible amount as shown by the fact that the control group gained on the average 3.28 points in I.Q. Because these negative results might have been due to the brevity of the interval elapsing between operation and retest it was necessary to give as many children as possible a third test after an interval of from ten to seventeen months following operation. Twenty-one pairs of children were secured for this delayed retest study. The average gain in I.Q. for the 21 operated cases was 3.0 whereas the average gain in

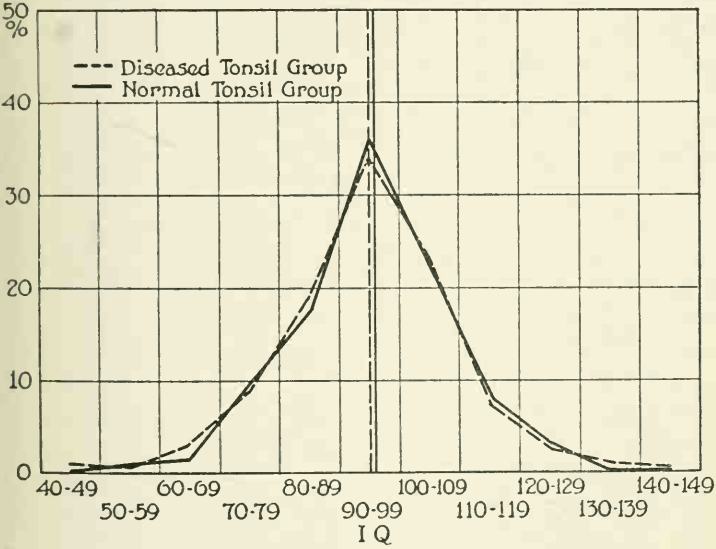

Fig. 11.

Percentage distribution of I.Q.'s for two groups of children, one group with diseased tonsils, the other group with normal tonsils. (Based on data from Rogers, *Arch. of Psychol.*, No. 50, p. 29.)

I.Q. for the 21 control cases was 6.2. On the basis of results like these it would seem that the author is beyond doubt justified in concluding that no substantial improvement in I.Q. results from operation, either after six months or after an interval of one year. Surely whatever startling benefits follow in the wake of tonsilectomy ought to manifest themselves within a year after operation. In final interpretation we subscribe wholly to the views of the author when she states, "Since there was no recuperation in intelligence resulting from operation for adenoids and tonsils, it is reasonable to expect that there had been no retardation from which to recuperate. This supposition is borne out by results of the statistical study, wherein we found that a group of children suffering from diseased tonsils possesses equal intelligence with a group which was free from such defect. We can say to physicians, then, with fair amount of assurance, that removal of adenoids and tonsils will probably not raise to any great degree the intelligence level of the mentally defective child who is brought to him. We can say to students of the constancy of the I.Q. that it is not greatly lowered by adenoids and diseased tonsils and we may say to the clinical psychologist that these defects have no demonstrable effect upon general intelligence, whatever effects they may have on volitional and emotional maturity."

Confirmation of the Roger's study is found in a similar investigation undertaken by Lowe.[20] Sixty children, diagnosed by the city school physician as having adenoids and diseased tonsils, were tested both following *recommendation* for operation and again a year later. However, since twenty-five of these children did not follow the recommendation whereas thirty-five were operated upon as recommended, it is possible to compare gain in I.Q. for the latter group considered as a test group and for the former group as a control. Average gain in I.Q. for the operated group was 1.6 points. Average gain in I.Q. for the control group was 2.2 points. Again, it appears that children suffering from diseased tonsils exhibit practically no gain in I.Q. at the end of a full year after operation.

Still another study on this same topic has recently been

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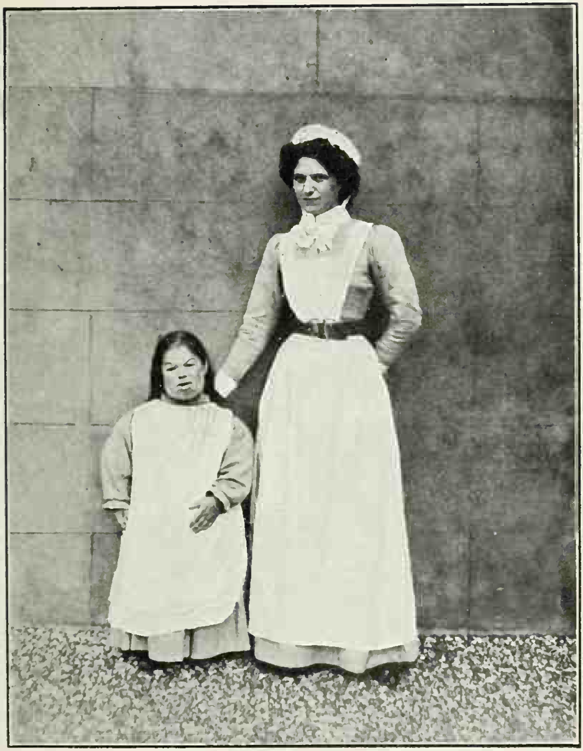
[20] G. M. Lowe, "Mental Changes After Removing Tonsils and Adenoids," *Psychol. Clinic,* 1923-24, 15:92-100.



Typical case of cretinism. Reproduced by permission from Tredgold, Mental Deficiency, London, Baillière, Tindall and Cox, 3rd Ed., 1920

published. Hoefer and Hardy report absence of relationship between condition of tonsils and I.Q. for a group of 343 elementary school children in Joliet, Illinois.[21] These children were carefully studied throughout a period of two years. Even at the end of this longer period no beneficial effects of improved tonsils upon I.Q. could be demonstrated.

The studies of Terman, Rogers, Lowe, and Hoefer and Hardy, employing objective mental tests (Stanford-Binet Scale), with remarkable agreement fail to disclose a perceptible effect of diseased tonsils upon brightness measured by I.Q. Justification for the removal of tonsils lies in the expectation of subsequent improvement in physical condition and well-being rather than in any supposed benefit to intelligence level.

4. Glandular Dysfunction

Cretinism, characterized by stunted growth and deficient intelligence, is known to be the result of absent or deficient secretion of the thyroid gland. (See accompanying illustration for a typical case of cretinism.) A remarkable improvement follows thyroid feeding. Arrested physical growth is overcome and normal growth reinstated. Mentality likewise is said to show similar improvement. Indeed, the earlier claims made in this regard were so positive that they have perpetuated extravagant notions. For example, Needham, in reviewing available evidence on bio-chemical foundations of human behavior assumes the issue to have been definitely settled, for he states: "I need not dilate upon the extraordinarily profound effects which the glands of internal secretion exert upon the mind and the body; they are already sufficiently well known. The administration of the active principle of the thyroid gland, for instance, can transform certain types of idiots into normal people in a very few days."[22] If this be so, why do cretins continue to be numbered among the inmates of institutions for the feebleminded? As a matter of fact, the administration of thyroid extract to cretins may result in remarkable physical changes without any corresponding mental improvement. Dr. Schlapp describes a case in which this physical improvement failed to be accompanied by mental improvement because the thyroid treatment was not begun until the child was four years old.[23] Conservative workers in this field do not hesitate to admit this. They stress the fact that significant mental benefits must not be expected to follow glandular therapy unless the diagnosis of cretinism is made early in infancy with prompt administration of thyroid extract which must be continued throughout life. However, the illustration (facing p. 210) from Dr. Kendall's Harvey Lecture shows that beneficial physical effects of thyroxin treatment may be obtained even though the treatment was not begun until ten years of age. Marked improvement in mentality was also noted. Even in cases where treatment is begun in early infancy there is no absolute guarantee of normal mental development. Tredgold cites two cases in which treatment was begun in infancy with a most gratifying physical improvement which, however, was unaccompanied by corresponding mental improvement.[24]

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[21] C. Hoefer and M. C. Hardy, "The Influence of Improvement in Physical Condition on Intelligence and Educational Achievement," *Twenty-seventh Yearbook of the Nat. Soc. for the Study of Education*, Part I, 1928, pp. 370-387.

In view of the too generally accepted supposition concerning alleged mental transformation of cretins immediately following appropriate glandular therapy it is extremely deplorable that the scientific literature does not contain abundant quantitative evidence on the question. I.Q.'s before, during, and after thyroid feeding should be reported. Such evidence as exists demonstrates that endocrinological therapy can by no means be regarded as a panacea for mental deficiency. Dr. Potter in reporting the extensive investigations carried out at Letchworth Village (institution in New York for mental defectives) states that "glandular feeding has been tried, but without any very striking results." [25] In this article setting forth the facts regarding improvement in Stanford-Binet mental age following appropriate glandular therapy for six months there are data upon 19 cases of Status-Thymico-Lymphaticus, 16 cases of Hypothyroid, and 18 cases of Dyspituitary. In about one-third of these cases mental gain was shown, this gain being inferred from a comparison with whatever mental growth had taken place before treatment began. Unfortunately there is no presentation of detailed data showing age, mental age, and I.Q. before and after treatment either for each case separately or for all cases taken together. Other data given tend to show that endocrinopathy is a serious problem among the feeble-minded, since 37 per cent of 849 unselected cases of mental defect in Letchworth Village showed evidence of glandular dysfunction. But this does not of itself establish that glandular therapy holds out hope for wholesale mental restorations. In this connection, Dr. Potter concludes, "We are of the opinion that only such cases of mental deficiency with an endoctrine dysfunction as have good heredity, are of moderately high-grade moron type, and are still in the developmental period of life, give any promise of favorable results with glandular feeding."

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[22] J. Needham, "Lucretius Redivivus: The Hope of a Chemical Psychology," *Psyche*, 7, 27, 1927, p. 12.

[23] Max Schlapp, M. D., "Causes of Defective Children," *J. of Heredity*, 1923, 14:387-397.

[24] A. F. Tredgold, *Mental Deficiency* (Baillière, Tindall, and Cox, London, 3rd Ed., 1920), p. 294.

The only detailed evidence in the literature on this subject which the writer has been able to locate is contained in a report by Edna Fox who reported on cases of glandular dysfunction found among 1867 heterogeneous cases passing through the Mental Clinic of the St. Vincent Hospital in New York since 1923.[26] Of these cases, 182 ranging in age between 3 and 16 were recorded as being due to some type of endocrine disorder and in each of these cases, glandular therapy was prescribed. The distribution of these cases in regard to diagnosis is shown in Table 36, together with the average I.Q., the lowest I.Q., and the highest I.Q. for each type of glandular disfunction. A glance at the column giving average I.Q. for each type of glandular disorder fails to reveal any definite relation between the type of disorder and intelligence. Furthermore, the average I.Q. of all these glandular cases is 74, whereas the average I.Q. of the total clinical group passing through the clinic is 78, indicating that glandular cases are not definitely differentiated from the usual run of clinic cases on the basis of I.Q. alone.

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[25] H. W. Potter, M. D., "Endocrine Therapy in Mental Deficiency," *Endocrinology*, 1923, 7:25-40. Also, *Mental Hygiene*, 9:779.

TABLE 36

Distribution of Glandular Cases Classified According to Diagnosis together with Data on I.Q.'s for Each Diagnostic Group. (After Fox.)

Diagnostic Group	*Number of Cases* *Boys*	*Girls*	*Average I.Q.*	*Lowest I.Q.*	*Highest I.Q.*
Hypothyroid	83	18	75	33	115
Hyperthyroid	1	2	81	59	94
Hypo-pituitary	16	7	74	30	110
Hyper-pituitary	2	0	57	52	61
Thyro-pituitary	2	1	77	71	90
Pluriglandular	8	42	71	30	108

Our interest in the Fox report centers on the additional data regarding I.Q.'s obtained by reëxaminations following glandular therapy for periods of from four months to over two years. These results are presented in Table 37. Unfortunately, this follow-up study is confined to a very small number of subjects. The evidence is suggestive, however, since little or no increase in I.Q. is demonstrated as an aftermath of appropriate glandular therapy. The gains are such as would be expected from repetition of the Stanford-Binet test upon a random sampling of untreated children. The author points out that greater gains might have occurred had the children been younger, yet within the clinical group studied and reported upon, the greatest gains in I.Q. were actually made by those from twelve to sixteen years of age rather than by those under twelve. Although the evidence is negative as regards appreciable gain in I.Q. there seems to have been evidence that these same cases showed distinct benefit from the glandular treatment so far as physical growth and improved emotional control are concerned.

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[26] E. J. Fox, "An Investigation of the Effect of Glandular Therapy on the Intelligence Quotient," *Mental Hygiene*, 1928, 12:90-102.

TABLE 37

Effect of Glandular Therapy upon I.Q. (After Fox.)

Diagnostic Group	*Number of Cases*	*Average Individual Gain in I.Q. Points*
Thyroid	12	+1
Pluriglandular	7	+4
Hypopituitary	3	−2
Total cases	22	+1.5

Suffice it to say that the meager evidence before us precludes, at the present time, definite conclusions concerning the precise amount of mental improvement to be expected from glandular therapy. We may be sure, however, that miraculous mental restoration as a result of endocrinological treatment does not ordinarily occur.

Extravagant statements in this field have not been confined to matters of treatment alone. Mere knowledge that cretinism is due to absence of thyroid secretion has led many writers to regard any diminution in normal thyroid gland function as bringing in its train extremely important mental consequences. Endocrinological speculation easily reverts from consideration of extreme cretinic condition to less pathological deviations. For example, Naccarati's morphological theories of intelligence were influenced by the known facts about thyroid deficiency and cretinism. No wonder that opinions regarding the association of mental retardation and thyroid malfunctioning, even when the degree of dysfunction is slight, have been broadcast within and without the circle of scientific medicine. It is high time that carefully controlled measurements should make it possible for opinion to be replaced by sober scientific formulation.

With reference to the mental significance of enlarged thyroid glands or simple goitre we are able to report two careful studies which should do much to counteract the exaggerated notions which have gained currency. The first study was made by Dr. R. Olesen of the United States Public Health Service in coöperation with Dr. M. R. Fernald, psychologist of the Vocation Bureau in Cincinnati, Ohio.[27] A thyroid survey was made in 1923-24 and during the same year the Vocation Bureau had given the Otis Advanced Intelligence Test to all sixth grade children in the Cincinnati Public Schools. The published report presents a combination of data from these two sources in such a way as to permit conclusions concerning the interrelation of endemic goitre and intelligence. Careful analysis of the data made it clear that age differences did not affect the prevalence of endemic goitre and hence data for a single school grade could be utilized without error arising from the age range existing within that school grade.

[27] R. Olesen and M. R. Fernald, "Endemic Goitre and Intelligence," U. S. Public Health Reports, 1926, 41:971-986.

The Otis scores were converted into percentile ranks thus making it impossible to compare the I.Q.'s of those suffering from simple goitre with those free from it. The comparisons are made, therefore, in terms of percentile ranks. Table 38 shows the percentage distribution of these cases in the five percentile groups (quintiles). The table is to be read as follows: Of 1292 boys in the sixth grade, 18.3 per cent of them tested in the lowest group (0 to 19 percentile scores), 23.9 per cent tested in the next lowest group (20 to 39 percentile scores), 22.2 per cent tested in the middle fifth (40-59 percentile scores), etc. Since the percentage distribution of scores in these five quintile groups is so similar for boys exhibiting enlarged glands and for boys with normal glands there is nothing to warrant the conclusion that one group is brighter than the other. A similar state of affairs is shown in the distribution of scores for the two groups of girls. A comparison of the median percentile scores for each group reveals again approximate equality of goitrous cases with non-goitrous cases. The authors conclude: "Considering, therefore, both the distributions as shown in the tables and charts, and the medians, it appears that the results of this study are largely negative, in that no relationship between

TABLE 38

Percentage Distribution of Sixth Grade Boys and Girls Classified as Possessing or Not Possessing Enlarged Glands on the Otis Tests Scored on the Basis of Percentiles. (Olesen and Fernald, *U. S. Public Health Reports*, 41, pp. 971-986.)

		Percentile Ranks Grouped in Quintiles				
		0–19	20–39	40–59	60–79	80–99
Boys	Normal (N = 1292).....	18.3	23.9	22.2	22.4	13.2
	Enlarged (N = 436) ...	19.9	26.6	17.2	23.0	13.3
Girls	Normal (N = 988)	16.0	21.3	22.4	21.7	18.7
	Enlarged (N = 642)	14.4	22.4	26.1	20.6	16.5

intelligence and the presence of thyroid enlargement has been demonstrated."

The other extensive investigation of this subject was reported by Stocks, Stocks, and Karn in a recent issue of Biometrika.[28] They followed the methods laid down by the Swiss Goitre Commission for measuring the extent to which the thyroid gland was enlarged. This involved measurement of the maximum breadth of the thyroid gland of 489 school girls. These measurements were then correlated with scholastic proficiency as determined by scholastic class ranks. The statistical competency of the workers and the care with which each series of measurements were developed for correlational purposes gives added confidence in the obtained results. Briefly, the resulting coefficient of correlation (statistical corrections for height and age having been made) was $+.08 \pm .03$. Such a finding would seem to disprove any definite or certain association between thyroid gland enlargement and mental retardation.

The extensive character of these two investigations and the professional competence of the investigators warrants belief in their soundness, both in technique and conclusions, even though negative results contrast sharply with the prevalent belief in simple goitre as a cause of mental subnormality and retardation.

5. Hookworm

Several investigations into the possibly pernicious effect of hookworm infections upon mentality point to a positive influence but experimental errors in the selection of subjects are very apt to be present so that we must beware inferring causal relations from the mere fact of association. Strong and Stiles administered the Goddard Revision of the Binet-Simon Scale to children in southern states and found that hookworm sufferers showed greater mental retardation than non-infected children.[29] A similar study by Waite and Nielson in Australia revealed a similar trend. They used the same mental measuring scale and subdivided the children into three classes, namely, non-infected, lightly infected, and heavily infected.[30] The average mental retardation was as follows: 116 non-infected children 3.9 months, 65 lightly infected cases = 9.3 months, and 159 heavily infected children = 23.4 months. However, these results are to be discounted heavily in view of known errors arising from the use of average mental retardation with heterogeneous age groups when the Goddard Revision is employed. This point was demonstrated at length in connection with the spurious mental retardation reported for delinquents by early users of the tests.[31] That this same age error (due to imperfect age standardization of the Goddard revision) is present in Waite and Nielson's study is shown by the fact that the difference between heavily infected and non-infected children shrinks to only six months when the chronological age group for which the Goddard Revision is best standardized (age 7.6 to 8.5) is selected for analysis. Obviously this difficulty of interpretation reduces the significance of the findings. Furthermore, since no measures of variability are reported we cannot judge the amount of overlapping which is unquestionably present.

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[28] P. Stocks, A. V. Stocks, and M. N. Karn, "Goitre in Adolescence; An Anthropometric Study of the Relation between the Size of the Thyroid Gland and Physical and Mental Development," *Biometrika,* 1927, 19(3/4):292-353.

[29] E. K. Strong and C. W. Stiles, "Effects of Hookworm Disease on the Mental and Physical Development of Children," International Health Commission no. 3, 1916.

[30] J. H. Waite and I. L. Nielson, "Effects of Hookworm Disease on Development of North Queensland Children," *J. of Am. Med. Assoc.*, 1919, 73:1877-1879.

[31] R. Pintner and Donald G. Paterson, "A Psychological Basis for the Diagnosis of Feeble-mindedness," *J. of Criminal Law and Criminology*, 1916, 7:32-56.

Finally, such differences as are reported may be due to social status differences.

The work of Smillie and Spencer is more easily interpreted since in their work the age factor is taken care of by an I.Q. procedure utilizing a fairly accurately standardized test (Otis Group Intelligence Scale).[32] In addition, they were able to utilize a more finely graduated scale of hookworm infection (five step scale ranging from absence of hookworms to a condition of from 500 to 2000 hookworms in the individual child). Table 39 gives the apparent relationship in terms of averages. Decrease in I.Q. is paralleled by marked increase in estimated number of hookworms per child, *on the average*. The phrase "on the average" is italicized because the actual degree of association is less than one would surmise from Table 39. We are able to judge this from an actual scatter table appearing in the article. This scatter table (rearranged to yield a positive r between relative freedom from hookworm and high I.Q.) is produced in Table 40. The writer has computed the Pearson r from these data and finds that its magnitude is +.30 ±.06.

TABLE 39

Otis I.Q. in Relation to Estimated Intensity of Hookwork Infection. (Smillie and Spencer, *J. of Educ. Psychol.*, 1926, pp. 314-321.)

Otis I.Q. Range	*Number of Cases*	*Av. No. Hookworms Per Case*
105–115	4	30
95–104	18	47
85–94	45	67.8
75–84	36	172
65–74	15	281

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[32] W. G. Smillie and C. R. Spencer, "Mental Retardation in School Children Infested with Hookworms," *J. of Educ. Psych.*, 1926, 17:314-321.

TABLE 40

Scatter Table Showing Relation Between Intensity of Hookworm Infection and Otis I.Q. for 117 Children. (Smillie and Spencer, *J. of Educ. Psychol.*, 1926, pp. 314-321.)

Pearson r = + .30 ± .06.

Otis I.Q. Range	INTENSITY OF HOOKWORM INFESTATION					
	Severe 501–2000 Worms	*Moderate 101–500 Worms*	*Light 26–100 Worms*	*Very Light 1–25 Worms*	*Negative Cases*	*Total*
105–115	0	0	1	3	0	4
95–104	1	1	2	6	8	18
85–94	0	10	16	14	5	45
75–84	6	10	4	14	2	36
65–74	3	2	4	3	2	14
Total....	10	23	27	40	17	117

In view of the relatively slight relationship indicated in the Smillie-Spencer data, there is scant justification for assigning to hookworm any such influential rôle in the production of individual differences in intelligence as it has been the custom to do. The fact that parents of low social status are apt to produce offspring with inferior mental status and, at the same time, provide unsuitable sanitary conditions predisposing such children to hookworm infection requires us to hesitate before asserting causal relation where mere association (and slight at that) may be all that the available evidence discloses.

6. Intestinal Toxemia

Only one study of the mental effects of intestinal toxemia has been reported.[33] Two groups of 30 subjects each were employed to determine whether remedial treatment for intestinal toxemia is accompanied by increase in mental and motor efficiency. The experimental group was composed of students exhibiting a definitely toxic condition upon entrance to the Physical Education and Domestic Science Training School connected with the Battle Creek Sanitarium. A control group consisting of students in the Berkeley Institute for Girls, of stenographers, and some Hunter College Freshmen was intended to be equated with them on the basis of Terman Group Test scores, age, training, and environment. It is unfortunate that the control group was not composed of Battle Creek Training students found to be free from toxemia. Such a control group would have permitted less ambiguous comparisons. Another limitation upon the precision of the experiment lies in the fact that the experimental group was informed of the purpose of the experiment although the information was withheld that the mental and motor tests given at the beginning of the remedial treatment would be repeated at the end of the treatment. Those in the control group are said to have coöperated out of interest and the desire to assist the experimenter. The Terman Group Test was not administered before the beginning of treatment nor at its conclusion, but some time during the one month's period of treatment. Thus the exact effect of the treatment on general intelligence cannot be determined from the data.

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[33] Alice Paulsen, "The Influence of Treatment for Intestinal Toxemia on Mental and Motor Efficiency," *Arch. of Psychol.* 11: no. 69, 1924, pp. 1-45.

Evidence is presented showing that the experimental group responded well to medical treatment, at the end of one month having progressed from a condition noted as "very bad" to a negligibly toxic condition. A variety of mental and motor tests were given. However, only one or two of the mental tests would qualify as a satisfactory test of intelligence, the majority being speed tests of special mental traits for the most part unrelated to "abstract intellect." The results seem to indicate that on the so-called *mental* tests a net improvement of 9 per cent. is shown by the experimental group in comparison with the control group, whereas on the *motor* tests a net improvement of 34 per cent. is registered. We are left with the conclusion, so far as this study is concerned, that intestinal toxemia reflects itself in little or no reduction in mental efficiency whereas it does effect rather markedly motor efficiency such as coördination, steadiness, accuracy of movement, grip, etc.

The prevalence of intestinal toxemia emphasizes the urgent need of further experimentation to determine more precisely and specifically its relation to intellect, and general mental efficiency .

7. Dental Caries and Impacted Teeth

The deleterious effect of dental caries (decayed teeth) and impacted teeth upon mental efficiency has frequently been asserted, usually on the basis of theoretical arguments rather than empirical data. It is unfortunate that some advocates of oral hygiene have made extravagant claims in its behalf, since if scientific verification of these claims should not be forthcoming, the legitimate objectives of dental hygiene may be placed in an unfavorable light. The writer recalls a case in point which came to his attention while serving as psychologist in the Ohio Institution for the Feebleminded in 1914. An imbecile with a mental age of about four years was committed from one of the larger cities of the state. Included among the commitment papers was a full page clipping from the magazine section of a Sunday newspaper which gave in great detail facts regarding the startling mental improvement of this patient following dental treatment during the preceding year. Photographic proof was included consisting of pictures of the patient "before and after treatment." In the photographs of the patient obtained before treatment the boy's expression is supposedly that of a mental defective,—relaxed facial muscles, open mouth, and lack of alertness in the dull eyes which portrays after the manner of the movies, the typical low-grade imbecile. In the pictures taken after dental treatment the boy's face is wreathed in smiles and an alert, highly intelligent facial expression is depicted. I was naturally somewhat non-plussed at this ocular evidence of mental restoration in view of the fact that the boy was at that moment before me with the same dull expressionless look as in the first photograph. But my perplexity was dispelled when one of the examining physicians produced a bright colored toy and I observed the boy's efforts to obtain possession of it. Alertness, smiles, and eagerness transformed the dull, vacant stare into an expression which would do credit to the most precocious youngster. The falsity of the evidence for "a remarkable improvement in intelligence" which according to the claim in the article had taken place as a result of dental hygiene was now apparent. This kind of episode argues powerfully for caution (yes, suspicion!) when claims of sudden and quasi-miraculous mental improvement resulting from medical, surgical, or dental treatment are unsupported by adequate quantitative evidence. We must remember that propaganda is sometimes misguided even when resorted to in behalf of legitimate and praiseworthy movements.

In view of the importance of the question before us it is unfortunate that adequate experimentation has not yet been undertaken and reported. A survey of the literature revealed only two experiments dealing with the mental effects of dental hygiene, and these two were on such a small scale as to leave the matter in a state of considerable uncertainty. Wallin, in 1912, reported a 50 per cent improvement in mental test performance in a group of 27 public school children in Cleveland, Ohio, following dental treatment throughout a year.[34] Lacking evidence which might have been obtained if a control group of children had been employed to serve as a check upon the findings we can not be sure that the improvement noted was solely a function of dental treatment. Considerable gain in test scores would have appeared anyway because of increased age and mental maturity. Furthermore, practice effects and heightened interest in the outcome of the tests can operate to bring about improvement in mental test scores. For reasons such as these we must suspend judgment concerning the significance of Wallin's evidence.

We are indebted to Miss Kohnky for a repetition of Wallin's work on a somewhat larger scale.[35] She employed a control group as a check upon the findings for the experimental group. Two comparable fifth grade classes in the same public school in Cincinnati, Ohio, were used in the experiment. The experimental class received all the care that dental science could give, including treatment, tooth-brush drills, dinners for instruction and practice in proper mastication, etc. Dentists, the school nurse, and a social worker coöperated with the class-room teacher and parents in making the oral hygiene as effective as possible. The other class was ignored and presumably the fact of maximum dental attention to the other class was suppressed or minimized as much as possible. Physical and mental tests were given at the beginning of the experiment in October and repeated at the end of the experiment in May of the following year. Eighty-five children, divided between the two classes, were involved.

The detailed data as given in the article have been organized into a single table and are presented in Table 41. It is obvious that improvement in height or in weight does not favor the experimental or treated class. This is rather surprising since one would suppose that if any benefits accrue from oral hygiene they would be most apparent in improved physical well-being, as reflected in increased weight or stature or both. The results obtained from the various mental tests, likewise fail to show any definite or certain trend in favor of the treated group. Differential gain in favor of the experimental class, when such occurs, is slight although absence of standard measures of variability preclude application of the usual mathematical test to determine the statistical significance of the differences. All in all, it is certain that no striking improvement in mental efficiency is exhibited by the experimental class in comparison with the gains made by the untreated children in the control class.

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[34] J. E. W. Wallin, Experimental Oral Euthenics, *Dental Cosmos*, April and May, 1912.

[35] E. Kohnky, "Preliminary Study of the Effect of Dental Treatment Upon the Physical and Mental Efficiency of School Children," *J. of Educ. Psychol.*, 1913, 4:571-578.

The above experiment should not be regarded as conclusive evidence that mental improvement does not accompany or follow from the conscientious application of dental hygiene. We need more experimentation, on a larger scale, over a longer period of time, and utilizing control groups sufficiently widely separated from the experimental groups so that knowledge of the purpose of the experiment may with certainty be withheld from both groups. Without attempting to pre-judge the results of such additional experimentation as may be undertaken, it is perhaps legitimate to remind ourselves of the fact that David Heron's extensive study of the relation between defective teeth and estimated intelligence as reported at the beginning of this chapter yielded negative results. We must also remember that no striking relation between the presence or absence of dental caries and pedagogical acceleration or retardation was found in the extensive surveys of Ayres or Cornell. Likewise, the study of Illinois school children by Kempf and Collins failed to

TABLE 41

Results of Experiment by Kohnky to Determine the Effect of Dental Treatment upon the Physical and Mental Efficiency of School Children. (Constructed from data given by Kohnky.) Note: Control class is designated by the letter C, experimental class by E.

Tests	*Class*	*Number of Children*	*Median Score in Oct.*	*Median Score in May*	*Gain*
I. *Weight (lbs.)*	C	38	67.5	76.5	9.0
	E	40	67.25	73	5.75
II. *Height, Standing (in.)*	C	39	53.2	56.1	2.9
	E	40	53.5	56.0	2.5
III. *Tapping Test*					
a. Right hand, total taps	C	41	295	308	13
	E	41	304	312	8
b. Left hand, total taps	C	41	242	253	11
	E	41	243	255	12
c. Fatigue-index, right hand	C	41	15.2%	13.1%	2.1%
	E	41	17.0%	12.5%	4.5%
d. Fatigue-index, left hand	C	41	15.1%	14.0%	1.1%
	E	42	17.5%	13.3%	4.2%
IV. *Cancellation "A" test (accuracy)*	C	40	61%	84%	23%
	E	37	56.5%	74.5%	18%
V. *Visual Memory Span for digits*					
a. Six digit series	C	40	87.5%	96.6%	9.1%
	E	38	91.6%	100.0%	8.4%
b. Seven digit series	C	40	71.4%	71.4%	0.0%
	E	38	74.9%	85.7%	10.8%
c. Eight digit series	C	40	56.3%	62.5%	6.2%
	E	38	59.3%	65.6%	6.3%
VI. *Substitution test*					
a. Sheet I.	C	43	201.6″	172″	29.6″
	E	38	206.5″	183″	23.5″
b. Sheet IV.	C	43	118.8″	110.5″	8.3″
	E	38	127.4″	104.9″	22.5″
c. Learning power (Diff. between Sheet I, trial 1, and Sheet IV, trial 4.)	C	43	201.6″	110.5″	91.1″
	E	38	206.5″	104.9″	101.6″

disclose any striking degree of association between such defects and measured intelligence.

In view of the available evidence, it would seem that condition of the teeth is not a very important factor conditioning the development of intelligence nor is dental treatment followed by great and certain improvement in mental efficiency. However, the experimental evidence is so meagre that no one can deny the desirability that further experimentation be conducted before the above conclusion is accepted as definitely established.

8. Other Physical Conditions

Any reader who happened to have served in the army or navy during the World War will have no difficulty in recalling the pronounced after-effects of the man-sized "shots" of typhoid inoculation either as he actually experienced them himself, or as he observed his comrades reporting verbally on the matter in question. Surely fair and reliable intelligence test scores could not be obtained from tests administered on the day following inoculations. No wonder resentment was expressed here and there when time schedules occasionally necessitated such precipitate testing programs. The army psychologists, themselves, did not approve of such a procedure but the mere pressure of numbers, on occasion, forced them to put up with such apparently undesirable examining conditions.

With a view to ascertaining the amount of influence exerted by recent typhoid inoculations and in order to provide "correction tables" if such proved to be needed in order to rate a soldier's intelligence fairly whenever necessity demanded examination following inoculation the matter was studied by the psychologists at Camp Custer. The intelligence scores of a group of 178 men recently inoculated, presumably within the preceding twenty-four hours, were compared with those made by 7,167 men from the July, 1918 draft not recently inoculated.[36] The average score of the recently inoculated men was 67.7; of the not recently inoculated men 67.1. Of course, many of the recently inoculated men felt no after-effects from the inoculation so that their scores may have raised the average for those feeling definite effects. Since these men were asked specifically to describe their condition at time of testing it is possible to check definitely on this matter. The average score of those who reported no after-effects was 67.9. The average score of those who felt that their intelligence score would be lowered by the after-effects turned out to be 67.4! Here is striking testimony regarding the lack of correspondence between subjective feelings and estimates of performance and actual proficiency under standardized testing conditions.

It must be admitted, of course, that the trend of evidence indicating only a slight relationship between physical defects and physical condition and intelligence runs counter to all our common sense notions. The evidence in the typhoid inoculation experiment runs counter even to the verdicts of those actually suffering from such after-effects.

To offset counter-attack from those who hate to abandon cherished beliefs even when confronted with overwhelming evidence we may quote Pearson and Moul's statement drawn up with the same end in view:

> "No doubt the indiscriminative critic will assert that we advocate poor physique, carelessness in the parent, uncleanliness in the child with overcrowding and poverty in the home. The workers in the Galton Laboratory are fairly inured to that type of criticism. They hold, however, that

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[36] "Psychological Examining in the United States Army," Memoirs of the National Academy of Sciences, vol. XV, Washington, Government Printing Office, 1921, ch. 13, Influence of Certain Physical Conditions on the Intelligence Score, pp. 809-811.

the decencies of life are worth fighting for and obtaining for their own sake, and without an adventitious stimulus from vague assertions that their absence is the chief source of stupidity, if not indeed of mental defect, in the child. Philanthropists, seeking to reform deleterious conditions, never gain in the long run, when they proclaim, without due research, that these conditions are the unquestionable cause of all concomitant evils."[37]

Verdicts of science which run counter to common sense notions must also survive another kind of attack, namely, denial of the significance or validity of the methods originally employed to procure the basic evidence. It is not surprising then to note that in certain quarters it is openly charged that our indices of intelligence whether in the form of I.Q.'s or Army Alpha letter ratings must be the product of very crude, insensitive, and perhaps invalid mental measuring instruments. Ruml, for one, vigorously assailed intelligence tests on this very point, stating:

"We should probably not admit that we, as individuals, are of the same general intelligence from time to time if we were very hard pressed on the point. . . . But an assumption of a static intelligence level is necessary to mental test work as it is now conceived. . . . Such an assumption seems based on a certain degree of uniformity as found in testing the same individuals at different times. So much the worse for the tests! If we did not need such an assumption so badly, we should question at once whether tests giving the same rating from time to time are not extremely insensitive measures of general mental adaptability."[38]

If Ruml's criticisms are valid our entire inquiry falls to the ground because of the absence of sufficiently valid measurements of intelligence to warrant investigations regarding the relation between physical traits and mental ability. However, the foundation of evidence for the validity of our modern intelligence tests obtained through pragmatic trials is now too strongly built to be overthrown by hasty or sweeping denunciations or impetuous obiter dicta. As a matter of fact, the continued piling up of negative evidence regarding any intimate correspondence between physical and mental traits may be thought of as nature's emphatic and mocking answer to a superficial and common sense notion, reflecting a shallow kind of insight in comparison with the profound importance of the great safeguards which have been thrown around the central nervous system. We turn then for further proof to instances where disease directly involves the central nervous system. The intellectual deterioration known to accompany paresis is an extreme case in point. No one could speak of an absence of causal relation between mental and physical here.

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[37] K. Pearson and M. Moul, *loc. cit.*

[38] Beardsley Ruml, "The Need for an Examination of Certain Hypotheses in Mental Tests," *J. of Phil., Psychol., and Sci. Methods,* 1920, 17: 57-61. For Dr. Terman's reply see L. M. Terman and T. L. Kelley, "Dr. Ruml's Criticism of Mental Test Methods," *J. of Phil., Psychol., and Sci. Methods,* 1921, 18:459-465.

9. Encephalitis Lethargica

A definite picture is unfolded by the mental sequaelae following hard upon recovery from certain diseases directly involving the central nervous system. The evidence is unambiguous that mental retardation may be a consequence of encephalitis lethargica.

Hallowell first described in the clinical terms relevant to our interest the marked behavior changes which follow an attack of encephalitis.[39] In 71 per cent. of her 24 cases (children) some sort of abnormality such as profound feeblemindedness, hyperkinesis, or abnormal mental slowness appeared as an after effect. The psychological examinations were given from three months to six years after onset of the disease and it is probable that not sufficient time had elapsed to reflect completely in terms of lowered I.Q.'s the full extent of arrest of mental development. However, the median I.Q. for these cases was 88, though the large majority of the group had manifested normal intelligence and normal school progress prior to attack. Lacking standard test scores obtained prior to the illness it is impossible, of course, to know for certain whether this median I.Q. of 88 represents merely a selection of mentally inferior children or an actual depression of I.Q. due to the disease itself. The case histories predispose toward the latter explanation.

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[39] D. K. Hallowell, "Twenty-four Cases of Acute Epidemic Encephalitis," *Psychol. Clinic*, 1925, 16:166-192.

With the fairly elaborate research of Dawson and Conn before us, we are more certain of the fact of mental impairment, though the actual amount of impairment will continue to be in doubt until a sufficient number of children have been given mental tests before attack and then retested at varying intervals of time thereafter.[40] Their results, based on C. Burt's Revision of the Binet Tests presumably yielding I.Q.'s comparable to the Sanford Revision, are of such great importance as to warrant extended summary.

The mean I.Q.'s of 46 encephalitic cases, tested from a few days to five years after onset, was 84.6 in comparison with a mean I.Q. of 90.5 for 974 non-encephalitic hospital children. The standard deviations of the means are such as to permit attaching definite statistical significance to the difference.

In analyzing the effect of lapse of time between attack and subsequent testing, another statistically significant difference was revealed:—Mean I.Q. of those tested *within* twelve months of onset was 89.5 whereas mean I.Q. of those tested *after* an interval of twelve months or more was 79.8.

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[40] S. Dawson and J. C. M. Conn, "Effect of Encephalitis Lethargica on the Intelligence of Children," *Arch. Diseases of Childhood*, 1926, 1:357-368.

In other words, there was an apparent drop of 10 I.Q. points given a lapse of time sufficient to permit the effect of mental arrest to manifest itself. This evidence suggests that the mental after-effects consist in an arrest of normal rate of development rather than actual mental deterioration.

A study of the brothers and sisters of 23 patients showed them to have a mean I.Q. of 96. This is some 10 I.Q. points higher than that of these patients (mean I.Q. = 85.6). Part of this difference might be explained as due to a natural trend of regression toward the mean. Additional evidence, however, suggests that the low mean I.Q. of encephalitics is not due to selection but rather to retardation. Twenty of these same 23 patients when tested for a second time after further lapse of time yielded a mean I.Q. of 76.4. This last figure when compared to the mean I.Q. of 96 for the normal brothers and sisters gives a clear picture of the degree to which the mental retardation was revealed at time of second testing.

Similar facts indicating a lowering of I.Q. from the first test to the second test were given for 30 cases. The usual finding for normal children is a slightly higher retest I.Q. as revealed in a number of studies. Here instead we find the retest I.Q. dropping from a mean of 87.7 at first test to 76.1 at second test. Not only is this a pronounced difference but the fact that a loss in I.Q. is reported for 27 of the 30 children is highly significant.

A preference for the interpretation of arrest of normal mental development rather than actual mental deterioration is manifested by Dawson and Conn when they state,

> "When an attack of encephalitis lethargica stops mental development, the degree of mental impairment it produces will depend on the age of the patient at the time of onset of his illness. . . . Older children show less deterioration because their development is arrested at a higher level, the

child of ten still retains his mental age of 10, and so may appear dull, stupid, and unable to profit from instruction at school, but he is not reduced to imbecility . . . while in a few cases encephalitis lethargica leaves no serious intellectual after-effects, yet it does on the whole arrest or retard mental development to such an extent that it appreciably reduces the intelligence of the patients, and that the deterioration is greatest in young children amounting sometimes to imbecility."

Undoubtedly similar positive findings would be disclosed if intelligence tests were applied to children suffering from spinal meningitis and other germ diseases attacking the central nervous system. At any rate such a suggestion seems reasonable in view of Goddard's statements compiled and generalized by him from observations and testimony of physicians.[41]

A study of crippled children in Cincinnati, Ohio, conducted by Fernald and Arlitt should be mentioned in this connection, since the conclusions and supporting data tend to confirm the point just made.[42] The mean I.Q. of 194 such children, classified as orthopedic cases only, was found to be 82.4. At first sight, one might conclude that all crippled children are retarded in mental development by virtue of their physical handicaps. But such is probably not the case since the mean I.Q. of the physically normal siblings of 49 of these crippled children was found to be 89.2. This is a difference which is negligible in view of the statistical regression toward the mean to be expected of mental measurements having less than perfect reliability. In general, then, it would appear that gross physical handicaps need

[41] H. H. Goddard, *Feeble-mindedness, Its Causes and Consequences*, (The Macmillan Company, New York, 1914), pp. xii+599.

[42] M. R. Fernald and A. H. Arlitt, "A Psychological Study of a Group of Crippled Children of Various Types—A Preliminary Report," *School and Society*, 1925, 21:449-452.

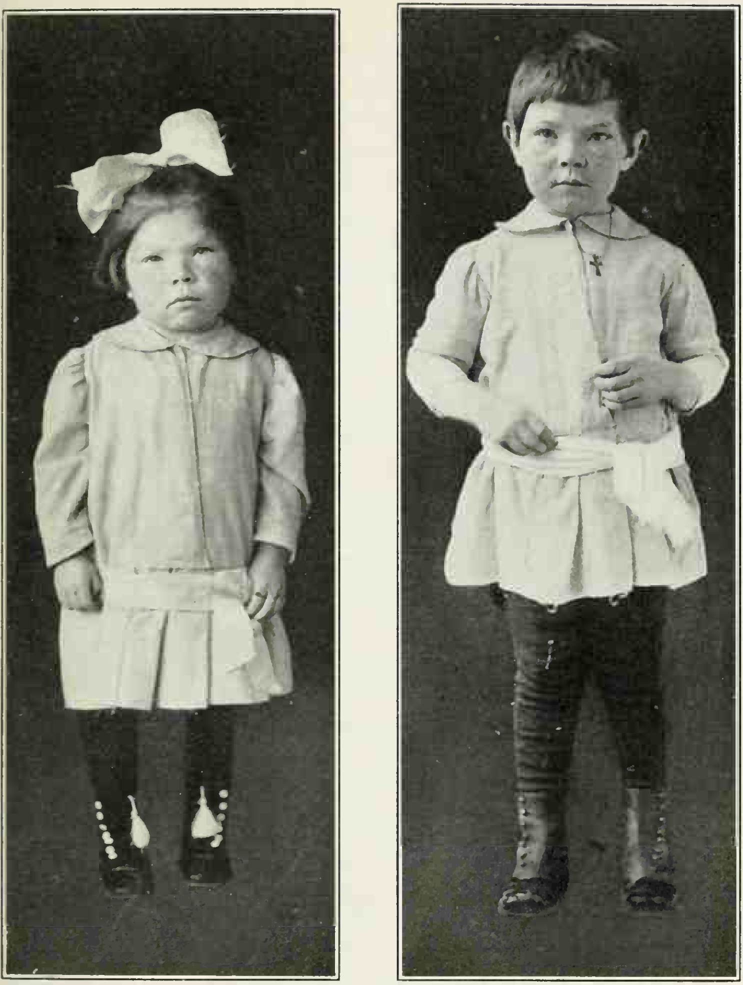

Illustration of beneficial effects of thyroxin treatment. Photograph at left shows child at the time thyroxin treatment was begun, at right one year later. Increase in height, six inches. Reproduced by permission from E. C. Kendall, The Harvey Lectures, 1919-20, Figure 17, p. 46. Photograph supplied by Dr. Henry S. Plummer, Mayo Clinic, Rochester, Minnesota

not occasion mental retardation. However, when the children are grouped according to the causes of their crippled condition, important differential trends are observed. The mean I.Q. of 62 children crippled as a result of poliomyelitis or infantile paralysis was 83.8. The mean I.Q. of 35 children suffering from tuberculosis of the bones, joints, etc., was 86.2. It is evident that these two conditions do not produce any noticeable amount of mental defectiveness. On the other hand, the mean I.Q. of 15 children who were suffering from conditions involving the central nervous system (lues, hereditary diseases, etc.) was only 75.9. Furthermore, the mean I.Q. of 27 children exhibiting spastic paralysis of birth (severe birth injuries to brain, mid-brain, and spinal cord) was 69.1. In these last two groups it is apparent that mental retardation may be attributed to disease or trauma. In other words, this investigation points quite clearly to the fact of mental retardation when diseases or injuries produce a deleterious effect upon the central nervous system.

10. Summary

We may briefly summarize this chapter by concluding that on the basis of available evidence the notions that dire mental consequences arise from physical defects and poor physical condition have been and still are greatly exaggerated. Such consequences as exist are demonstrable for mankind in the mass only to a slight degree.

With the exception of diseases and injuries directly involving the central nervous system itself, it would appear that we cannot explain the tremendous range of individual differences in intellect on the hypothesis that unfavorable physical condition or specific physical defects are operative as a major causal factor. Apparently, nature has so safeguarded the central nervous system as to render normal mental development relatively secure or at least strongly immune to such deleterious influences as malnutrition, diseased tonsils, enlarged adenoids, defective breathing, defective teeth, simple goiter, intestinal toxemia, and even hookworm. This, the present verdict of science, does not preclude, of course, the possibility that more sensitive mental measuring instruments may some day reveal the existence of important relationships not now evident. Finally, our present negative evidence must not be construed as justifying any diminution in the expenditure of thought, money, effort, and technical skill in vigorously pushing forward every sound proposal for improving the physical condition and health of mankind. Surely the maintenance of physical fitness is an end in itself and need not be called upon to justify itself in the additional terms of mental improvement wherever and whenever gains in physical efficiency and well-being are demonstrable.

Chapter VII

PHYSIQUE AND TEMPERAMENT

IN this chapter we will survey what is known to science about the relationship between various physical traits and non-intellectual aspects of personality. For convenience, we have used the single word "temperament" in our chapter heading to denote these non-intellectual characteristics. In the discussion, however, we will at times be concerned with a variety of personality traits some of which could not reasonably be considered as constituent parts of temperament.

Obscure relationships between endocrine gland functioning, physical characters, and non-intellectual personality traits may and probably do exist.[1] There is good reason to believe that positive and causal connections will eventually be laid bare as the result of one or more of the many possible approaches to this complicated problem. There have always been persons who have not hesitated to formulate elaborate "systems" of character analysis based upon physical signs and symptoms. Such pseudo-scientific systems as physiognomy, phrenology, graphology, and a dozen more or less known but equally elaborate and non-quantitative schemes might be cited. Contrasting with these, we have legitimate attempts to develop characterology on a physical basis as illustrated in the work of Berman, Naccarati, and Kretschmer. Psychologists, in recent years, have been keenly alert to the possibility of important discoveries in these fields of research and have begun extensive investigations which demand and merit consideration.

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[1] For a brief treatment of this subject see E. Miller, *Types of Mind and Body* (W. W. Norton and Company, New York, 1927), pp. 1-95. This book is extraordinarily readable, not to say fascinating in its style and method of presentation. Its most serious shortcomings are oversimplification of the problem and a non-quantitative approach to it, both of which faults lead to broad sweeps of generalization.

1. Physiognomic Traits in Relation to Temperament

Perhaps Katherine Blackford holds first place in America as a modern exponent of physiognomy—the so-called science and art of judging character from the features of the face. Elaborate rules are provided for interpreting the significance of blondness, height of forehead, size and shape of head, mouth, nose, and eyes, voice quality, texture of skin, bodily build, posture, hardness or softness of muscles, gait, handshake, gestures, clothing, etc. A mere listing of characteristics for which interpretative rules have been evolved indicates the comprehensive complexity of the system.

Perhaps Blackford's exposition of the so-called law of color (blond versus brunette characteristics) may be used as the best illustration though any of the other eight physical variables underlying her system of character analysis might do almost as well. In describing blond vs. brunette characteristics, she states: "In brief, always and everywhere, the normal blond has positive, dynamic, driving, aggressive, domineering, impatient, active, quick, hopeful, speculative, changeable, and variety-loving characteristics; while the normal brunette has negative, static, conservative, imitative, submissive, cautious, painstaking, plodding, slow, deliberate, serious, thoughtful, specializing characteristics."[2] Furthermore, Dr. Blackford assures us, on the same page, that her law of color is simple and straightforward. To quote: "In applying this law of color to people of the white race, the method is simple. The less the pigmentation in any individual, the more marked the characteristics of the blond in his physical, mental, and psychical nature; the greater the degree of pigmentation, the more marked the characteristics of the brunette."

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[2] Katherine M. H. Blackford, M. D., and Arthur Newcomb, *The Job, The Man, the Boss* (Doubleday, Page and Co., Garden City, N. Y., 1919), p. 141.

It occurred to the writer that such positive assertions ought to be put to a quantitative test and, in collaboration with Dr. Katherine E. Ludgate, an attempt at verification was undertaken.[3] We held that if blonds as a group, always and everywhere, exhibit or at least possess traits that are positive, dynamic, driving, etc., then blonds individually should possess such traits. If this were so, then a majority at least of blonds should be rated by intelligent, educated judges as being the possessors of those traits. Furthermore, a large majority of blonds should be rated as being deficient in the brunette traits. The opposite results should hold, of course, for ratings secured on brunettes.

Accordingly, we prepared a rating sheet on which were listed the 26 traits in random order. Each of 94 judges was asked to select from among his acquaintances two pronounced blonds and two pronounced brunettes and to rate them with respect to presence or absence of each trait or characteristic. In this way, we secured ratings on 187 blonds and 187 brunettes.

The ratings for blonds and brunettes were tabulated separately and the percentage of blonds rated plus (+) in each trait and the percentage of brunettes rated plus (+) in each trait was then computed. These computations are shown in Table 42 and in Figure 12. It is obvious that these

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[3] Donald G. Paterson and Katherine E. Ludgate, "Blond and Brunette Traits: A Quantitative Study," *J. of Personnel Research*, 1922, 1:122-127.

Table 42

Percentage of Blonds and Brunettes Rated Plus (+) in Each of Blackford's So-called Blond and Brunette Traits. (After Paterson and Ludgate.)

	PERCENTAGE RATED PLUS (+)	
	187 Blonds	*187 Brunettes*
Blond traits:		
Positive	81	84
Dynamic	63	64
Driving	49	50
Aggressive	62	56
Domineering	36	36
Impatient	56	51
Active	88	82
Quick	70	68
Hopeful	85	85
Speculative	53	51
Changeable	53	43
Variety-loving	66	62
Average	64	61
Brunette traits:		
Negative	16	17
Static	28	31
Conservative	51	61
Imitative	39	40
Submissive	25	26
Cautious	54	60
Painstaking	56	61
Patient	43	52
Plodding	27	31
Slow	20	24
Deliberate	47	57
Serious	58	72
Thoughtful	67	70
Specializing	52	45
Average	42	45

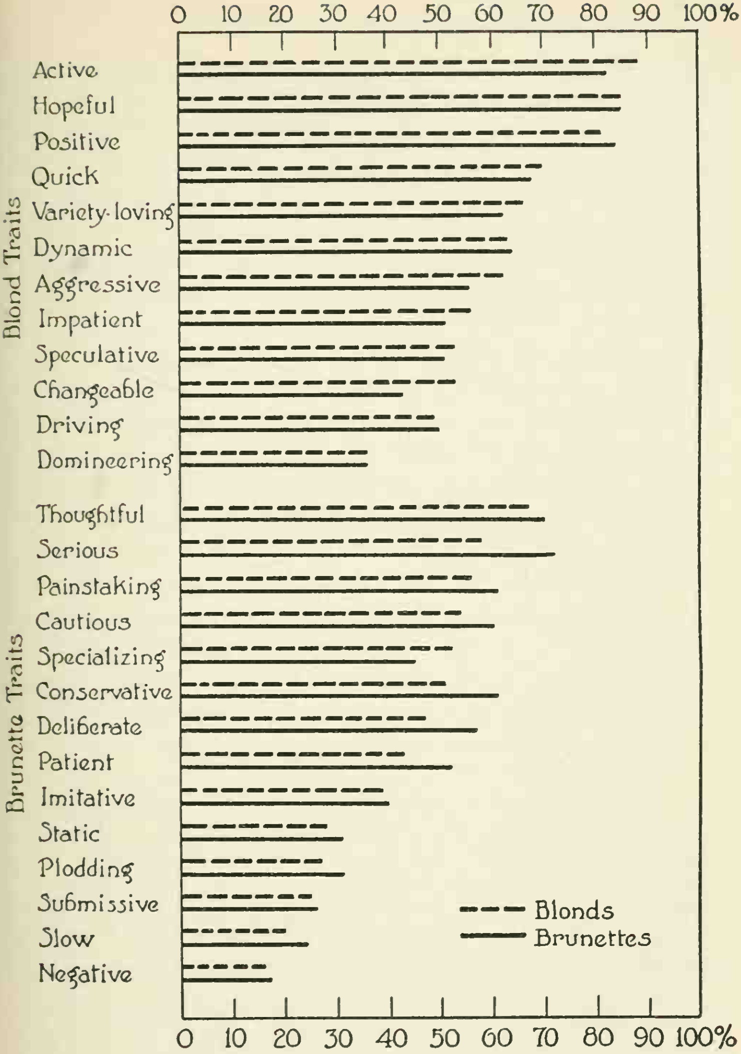

FIG. 12.

Bar diagram showing percentage of blonds and brunettes rated plus (+) in each of Blackford's so-called blond and brunette traits. (Based on data from Paterson and Ludgate.)

so-called blond and brunette traits fail to differentiate real flesh and blood blonds and brunettes. The percentage of brunettes possessing the blond traits is approximately as large as the percentage of blonds possessing blond traits. Likewise, the percentage of blonds possessing brunette traits is also very similar to the percentage of brunettes possessing brunette traits. This result is a flat contradiction to what one has a right to expect if Dr. Blackford's generalization is true.

This experiment has been repeated by Kenagy of the Carnegie Institute of Technology, who secured the coöperation of salesmanagers in some forty national organizations in rating 152 highly successful salesmen (82 blonds and 70 brunettes).[4] The results are almost identical with those of Paterson and Ludgate negating Blackford's claims not only for the so-called law of color but also the claims for applicability of the method in the selection of salesmen.

One other attempt experimentally to verify one of Blackford's assertions may be mentioned in passing. Hull reports the work of one of his students (Alice L. Evans) in which the matter of the convex versus the concave profile was subjected to study.[5] Blackford had stated:

> "The significance of the pure convex type is energy, both mental and physical. Superabundance of energy makes the extreme convex keen, alert, quick, eager, aggressive, impatient, positive, and penetrating. . . . The pure concave, as might be expected, is the exact opposite. . . . The keynote of his character is *mildness*. . . . He is slow of thought, slow of action, patient in disposition, plodding." [6]

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[4] H. G. Kenagy, "Do Blonds Make the Best Salesmen," *Sales Management*, Feb. 1923, pp. 325-326.

[5] C. L. Hull, *Aptitude Testing* (World Book Company, Yonkers, N. Y., 1928), pp. 127-130.

[6] Katherine M. H. Blackford and Arthur Newcomb, *op. cit.*, pp. 154-156.

By means of an ingenious measuring device Hull and Evans measured with great care the precise degree of convexity of the profiles of each of 25 members of a university sorority. Five different measurements of convexity were obtained. These measurements were then correlated with a series of character trait ratings secured by having each sorority member rate each other member. The character traits rated were optimism, activity, ambition, will power, domination, and popularity. With such a small number of subjects the resulting coefficients of correlation would naturally have very high probable errors and hence would fluctuate within rather wide limits. As a matter of fact the thirty coefficients ranged from −.27 to +.39, 16 being negative and 14 positive. The best indication of the real relationship between convexity of profile and these character traits would seem to be the average of the thirty coefficients. This, when computed, turned out to be +.01, a figure as close to zero as could be expected on the basis of chance alone.

Perhaps the most elaborate attempt to verify physiognomic claims is to be found in the work of Cleeton and Knight.[7] To test the hypotheses that judgment, intelligence, frankness, will power, ability to make friends, leadership, originality, and impulsiveness are revealed by various physical characteristics a total of 122 physical measurements were made on each of thirty subjects. Ratings of these character traits as exhibited by the thirty subjects were secured from intimate associates and pooled in such a manner as to yield an unusually reliable index of those traits. These pooled ratings were then correlated with each of the physical measurements, with the net result that the average of the 201 correlations between physical traits and character traits (declared by character analysis to be closely related to the physical traits) is exactly zero. Here is devastating statistical refutation of the fantastic claims put forward by the high priests of physiognomy and phrenology.

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[7] G. U. Cleeton and F. B. Knight, "Validity of Character Judgments Based on External Criteria," *J. of Appli. Psychol.*, 1924, 8:215-229.

2. Morphologic Types In Relation to Personality Traits

In the foregoing section we have reviewed evidence contradictory to the notion that physical characters are significantly related to personality traits after the manner asserted in physiognomy and phrenology. Now, we turn to not so dissimilar theories which grow out of clinical practice and psychopathology, but for which there is somewhat greater hope of verification.

Naccarati pushed his morphological theories beyond the theory of a relation between physique and intellect when, in 1924, he published two experimental papers designed to show the relation of body build to emotional instability among normal subjects and to definite psychoneuroses among the abnormal.[8]

In previous papers Naccarati had insisted that his morphological index should be applied only to younger persons, preferably between the ages of 20 and 25. However, in his study of 100 Italian, male psychoneurotics he fails to introduce a discussion of the factor of age in its influence on his morphological measurements. Since these subjects ranged in age from 25 to 40 it would seem possible to question the significance of his findings. The principal conclusions are:

1. The percentage of microsplanchnics and of macrosplanchnics is higher among psychoneurotics than among an equal number of normal individuals of the same age.

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[8] S. Naccarati, "The Morphologic Basis of the Psychoneuroses," *Am. J. of Psychiatry*, 1924, 3:527-545, and S. Naccarati and H. E. Garrett, "The Relation of Morphology to Temperament," *J. of Abn. and Soc. Psychol.*, 1924-25, 19:254-263.

2. Neurasthenics yield relatively more microsplanchnics.
3. Emotional psychoneurotics yield more macrosplanchnics.

These findings are discussed at great length with emphasis upon theoretical considerations as explanations. For example, the microsplanchnic is said to be a candidate for the asthenic forms of psychoneuroses (neurasthenia) primarily because of deficient muscular development secondary to poor organic functions. In such individuals "the catabolic processes predominate over the anabolic processes, and this is the primary cause of fatigue." On the other hand, the macrosplanchnic possesses more energetic vegetative functions, is more susceptible to instincts and emotions, and hence is a candidate for the emotional psychoneuroses such as hysteria, anxiety neuroses, traumatic neuroses, and other typical forms of emotional disturbance.

In explanation of the relative freedom from the psychoneuroses enjoyed by normosplanchnics he asserts:

> "The normosplanchnic in fact represents the average type of the race, the prototype from the eugenic point of view, who possesses the greatest degree of resistance toward any internal or external pathogenic factors. The other two types, the macrosplanchnic and microsplanchnic who, during the period of development, deviated from the average ethnic type in virtue of the 'law of deformation' of Viola, are subject to lose more easily that dynamic balance of the organic functions, which the better-fit individuals of the race preëminently possess."

Naccarati's evidence cannot be accepted without reservations. The conclusion that there is a reduced percentage of normosplanchnics among psychoneurotics is unsupported by comparative data showing the distribution of morphological indices among normal, Italian males, aged 25 to 40. Inspection of the raw data does not indicate any very definite tendency for the morphological indices of these two groups of psychoneurotics (asthenic group and the emotional group) to be distributed in a bi-modal curve. As a matter of fact, a coarse grouping of the indices shows 10 to be above 550, 31 between 450 and 550, 31 between 350 and 450, 23 between 250 and 350, and 5 to be below 250. It would appear that the distribution is fairly normal, unimodal in character, and not at all suggestive of any diminution of indices at the middle of the scale. However, a distinct difference in morphological index between the asthenic and the emotional types of psychoneuroses is apparent. The median index of the 50 asthenic cases is 460 (tending toward microsplanchny since the extremities predominate over the trunk volume) whereas the median of the 50 emotional cases is 375. Forty individuals or 80 per cent. of the asthenics reach or exceed the median of the emotional cases. Unfortunately we are not adequately informed regarding the conditions surrounding the collecting of these data. Where was the study made? Were the diagnoses made by psychiatrists in complete ignorance of the morphological measurements? Were the diagnoses made by psychiatrists who themselves are free from belief in morphological types? In work of this sort, where uncertainty in diagnostic classification frequently exists, it is essential that every possible precaution be taken to prevent theoretical presuppositions from producing biased data to be later used in verifying the theory itself.

An attempt to verify his belief that macrosplanchnics are more unstable emotionally than normosplanchnics or microsplanchnics was made by Naccarati in collaboration with Garrett. They studied 54 presumably normal college men, students at Columbia University. The Woodworth Personal Data Sheet which is designed to measure psychoneurotic trends was used.[9] The group was divided into three classes on the basis of the Woodworth scores. A small score indicates freedom from emotional instability. The average morphological index for each class was computed together with the usual measure of variability. The results are presented in Table 43. Interest centers in the results for Group III which includes those exhibiting the greatest emotional instability as measured by the Woodworth questionnaire. Additional data, based upon ratings of physique, intelligence, emotional stability, and aggressiveness made by instructors and classmates, were presented showing that Group III is estimated to be lower than Groups I and II in intelligence and emotional stability. It is apparent that the morphological index is some 31 points lower than for Group II and 38 points lower than Group I. Apparently, there is a tendency for the emotionally unstable group of students to exhibit lower morphological indices. In other words, emotional instability seems to be associated with macrosplanchny. But note that the average morphological index of these emotionally unstable students is actually slightly higher than the mean morphological index of the asthenic psychoneurotics, reviewed above. In the former article the

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[9] For an account of this questionnaire method see S. I. Franz, *A Handbook of Mental Examination Methods;* 2nd edition (The Macmillan

TABLE 43

Showing Average Morphological Index (and S.D.) for College Students Subdivided on Basis of Score on the Woodworth Personal Data Sheet. (Naccarati and Garrett.)

	Group I N = 18	*Group II* N = 16	*Group III* N = 20
Woodworth P. D. Score, Ave. . .	6.9	14.2	24.8
Morphological Index, Ave.	498.5	495.0	460.8
" " S. D.	61.3	57.5	56.0

Company, New York, 1919), pp. 193; also, H. L. Hollingworth, *Psychology of the Functional Neuroses* (D. Appleton and Company, New York, 1920), p. 259.

asthenic psychoneurotics with a mean index of 456.6 were described as tending toward microsplanchny. In this study, the emotionally unstable group of students with a mean index of 460.8 is discussed as if they tend toward macrosplanchny. Surely we are justified in insisting upon the adoption of a dividing line, however arbitrary, which will separate the morphological indices of microsplanchnics, normosplanchnics, and macrosplanchnics, to obviate this shifting of interpretation from one study to another.

The authors attach considerable theoretical significance to the results obtained. They say:

> "In a previous report we have shown that there is a small but positive relation between the morphologic index and general intelligence. This relation, we suggested, was very probably due to the action of the endocrine glands, especially the thyroid. It now appears that there is also a positive relation between the morphological index and temperamental or emotional stability. We can now, therefore, go a step further and say that those endocrines which affect the morphology and the mentality of a given individual, very probably influence his emotional life also."

However, the tentative nature of the conclusion, due to the small number of cases, is definitely recognized by the authors. We wish to observe also that the method of averages employed in their paper tends to magnify whatever amount of relationship may be present. Therefore, we can accept the results only as a rough exploration to "scout" the possible existence of a relationship. The precise amount of relationship, of course, can be revealed only by use of correlational techniques.

In view of the tentative nature of Naccarati's findings, the more extensive investigation conducted at a later date by Garrett in collaboration with Kellogg is highly significant. A description of this experiment has already been given in Chapter IV in connection with the relation between morphological index and intelligence.[10] Our interest, here, centers on the relation between morphological index on the one hand and emotional stability (as measured by the Woodworth Personal Data Sheet) and social intelligence (as measured by the George Washington Social Intelligence Test) on the other. The correlations are presented in Table 44. These correlations hover around zero and in view of the magnitude of their probable errors may be said to be zero. The authors advance such an interpretation when they state, "We are forced to the conclusion that there is no real evidence of significant relationship—linear or otherwise—between our indices of build and our tests of general intelligence, social intelligence, and emotional instability." In the absence of significant relationships it is at once obvious that we are freed from the temptation to indulge in elaborate endocrinological speculations like those characteristic of Naccarati's publications.

TABLE 44

Coefficients of Correlation Between Physique (Morphological Index and Ht/Wt Ratio) and Emotional Stability (Woodworth P.D. Sheet) and Social Intelligence (George Washington Test). (After Garrett and Kellogg.)

Tests	*N*	*r*	*r (corrected for attenuation)*
M.I. and Woodworth P.D. Sheet	151	.05 ± .06	.05
Ht/Wt and Woodworth P.D. Sheet	150	.09 ± .05	.09
M.I. and Social Intell.	123	—. 06 ± .06	—.06
Ht/Wt and Social Intell.	122	.05 ± .06	.06

Sheldon, working at the University of Chicago, secured trait ratings on 155 freshman men, each of whom were rated by five upperclassmen judges belonging to the same fraternity and who were by virtue of this presumably in a favorable position to render reliable and valid judgments.[11] The traits selected for study were, sociability (good-nature, likeableness, popularity), perseverance (determination, tenacity of purpose), leadership (domination of a group, influencing their thinking and actions), aggressiveness (pushing oneself forward, self-assertiveness), and emotional excitability (expressing oneself violently, raising the voice, losing temper, getting angry, flushed and wrought up easily). Morphological measurements were obtained following minutely Naccarati's procedure. The resulting coefficients of correlation are presented in Table 45. The probable errors of these correlations are large. Only two of the correlations

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[10] H. E. Garrett and W. N. Kellogg, "The Relation of Physical Constitution to General Intelligence, Social Intelligence, and Emotional Stability," *J. of Exper. Psychol.*, 1928, 11:113-129.

TABLE 45

Coefficients of Correlation Between Morphologic Measurements and Personality Trait Ratings. N = 155. (After Sheldon.)

	Emotional Excitability	*Aggressiveness*	*Leadership*	*Sociability*	*Perseverance*
Morphologic Index	—.00	—.08	—.14	—.22	.01
Length of lower extremities	.06	.14	.00	—.07	—.01
Length of upper extremities	.07	.03	.02	—.00	—.02
Sternum length	.03	.11	.15	.05	.06
Xipho-epigastric	.06	.00	.07	—.09	—.02
Transverse thoracic diameter	.11	.17	.11	.00	—.01
Anterior-posterior thoracic diameter	.04	.08	.02	—.01	—.03
Transverse epigastric diameter	.04	.24	.08	.03	—.11
Anterior-posterior epigastric diameter	.04	.06	.01	.01	—.05
Transverse pelvic diameter	.03	.09	.03	—.08	.04
Height	.09	.13	.05	.00	—.07
Weight	.08	.07	.02	.13	.03
Average	.05	.09	.04	—.02	—.02

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[11] Wm. H. Sheldon, "Social Traits and Morphologic Types," *J. of Personnel Research,* 1927, 6:47-55.

are as much as four times their probable errors, hence we are barred from utilizing these coefficients to measure the *exact* amount of relationship. Possibly there is a suggestion of a very slight relationship between the factor of bigness or bulk (macrosplanchny) and sociability, leadership, and aggressiveness, but the correlation is very slight. At best the trend emerges haltingly. With reference to emotionality, it is evident that Naccarati's thesis again fails of confirmation.

3. Body Build and Physical Defects in Relation to Adler's Concept of "Organ Inferiority"

Hanna Fay Faterson, in her recent doctoral dissertation, made an extensive study of the Heidbreder Inferiority Attitude Self-rating Scale, under the direction of Dr. E. Heidbreder and the writer.[12] She attempted to determine for college students the relationship between scores on the self-rating scale and other measures: the Minnesota College Ability tests, college scholarship, three tests of emotional attitude (the Woodworth Psychoneurotic Inventory or Personal Data Sheet, Heidbreider Worries Scale, and Heidbreder Introversion-Extraversion Scale), an interest analysis blank, social-economic status, the height-weight ratio, and physical defects. At this point our interest centers on the findings as regards the height-weight ratio, and physical defects.

The description of the construction of the scale, together with preliminary results, has been published by Heidbreder.[13] One hundred and thirty traits were listed, each to be rated with reference to degree of presence or absence. These traits were culled from the writings of Alfred Adler, originator of the inferiority complex concept, who pronounces them symptomatic of feelings of inadequacy. Self-ratings and associates' ratings for 268 college students, when subjected to statistical analysis, revealed that the rating questionnaire contains a consistent set of traits, each item differentiating between the extremes of the distribution of subjects obtained by totaling the number of ratings indicating possession of inferiority traits as described by Adler. Those groups of traits which are theoretically most diagnostic proved to yield the largest significant differences between the extremes of the distribution. These statistically most significant traits are preoccupation with self and feelings of inadequacy, as may be seen from the following samples: Is self-conscious, is sensitive to blame, is given to self-criticism, is dissatisfied with his progress and achievements up to the present time, is given to remorse and regrets, and hesitates to put his abilities to the test. Additional analyses show that the list of traits as a whole furnishes scores which are distributed normally with no apparent tendency for bi-modality, that the scores for women are higher than for men, that self-ratings are characterized by higher scores than are associates' ratings, and that there is a general tendency toward overcompensation and overreaction among those who secure high scores. The coefficient of correlation between original test and retest six weeks later for 147 students is $+ .73 \pm .03$, indicating a satisfactory degree of reliability for the experimental uses to which the device has been put.

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[12] Hanna Fay Faterson, "Some Implications of the Normal Inferiority Complex," a thesis submitted to the graduate faculty of the University of Minnesota in partial fulfillment of the requirement for the degree of Doctor of Philosophy, 1928.

[13] E. F. Heidbreder, "The Normal Inferiority Complex," *J. of Abn. and Soc. Psychol.,* 1927, 22:243-258.

The scoring key, as used by Faterson, yields "weighted" plus or negative values for 94 of the most significant traits. An algebraic sum is obtained for each subject, high positive scores presumably indicating the highest degrees of inferiority with low negative scores indicating the reverse. The average score for 1424 University of Minnesota freshmen, men and women combined, is + 39.2, with standard deviation of the distribution 40.2. The odd-even reliability of this revised scale is + .72 ± .02 which becomes + .84 ± .01 when corrected by the Spearman-Brown prophecy formula.

The correlations between the Inferiority Attitude Scale and the other tests of emotional stability are sufficiently pronounced to warrant its use as a more or less valid measure of neurotic temperament, as ordinarily defined. The extent to which this neurotic temperament is conditioned by body build and physical defects is of great theoretical interest in view of the emphasis which Adler has placed upon "organ inferiority" as the physical basis for the genesis of feelings of inadequacy.[14]

For 673 freshman men a correlation of + .03 ± .03 was found between the height-weight ratio and Inferiority Attitude score. The correlations between height and weight separately with Inferiority Attitude score were likewise negligible. However, for 531 freshman women a very slight but apparently definitely established correlation of + .11 ± .03 was obtained. The correlation for height was + .10 ± .03 and for weight was − .10 ± .03. Apparently, there is a slight tendency for those who are tall and thin (tall and underweight relative to the average of the group) to rate themselves higher on the scale. As Faterson points out, the correlations for the men do not support the popular belief that the undersized man is apt to exhibit an unusual degree of aggressiveness as a compensation for feelings of inadequacy. The correlations for the women suggest that there is a slight tendency for them to be sensitive about their height. In view of the unremitting efforts of modern women to "reduce" and to avoid at all costs even a slight excess of weight it is somewhat surprising to discover that the freshman girl who deviates from the average in the direction of plumpness actually tends to have lower Inferiority Attitude scores.

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[14] Alfred Adler, *Study of Organ Inferiority and its Psychical Compensations*, trans. by S. E. Jelliffe. *Nervous and Mental Diseases Monograph Series, No. 24* (Nervous and Mental Diseases Publishing Co., New York, 1917). Also Alfred Adler, *The Neurotic Constitution*, trans. by Bernard Glueck and John E. Lind (Moffat, Yard and Co., New York, 1917).

Analysis of the medical examination blanks of these subjects showed that a majority of the physical defects were positively related to Inferiority Attitude scores. That is to say, the average score for those possessing particular defects tends to be higher than the average score for those not possessing these defects. Suspecting that it is the *general* condition of being physically below par rather than the presence of any *particular* defect which is responsible for the higher Inferiority Complex scores obtained by those possessing various defects, Faterson proceeded to correlate "total defect scores" with the scale. For 680 men the Pearson correlation is + .16 ± .03 and for 549 women the correlation is + .24 ± .03. These two correlations are based on total number of defects per student recorded on the physical examination record blanks as significant by the physicians. Another correlation was obtained for women students between self-estimates of health and physical condition as shown by a list of items identical for the most part with those covered by the regular physical examination. This correlation is + .30 ± .03.

In a sense these findings constitute a positive verification in general of Adler's thesis. The relationship between "organ inferiority" and feelings of inferiority which Adler discovered in his extensive clinical study of the neurotic temperament was found by Faterson to exist to a slight though definitely established degree among "normal" college students. That the correlation is no higher need not occasion surprise in view of the fact that the Heidbreder scale admittedly is not a perfectly reliable instrument of measurement. Nor would any one claim that it yields a completely adequate and valid measure of the inferiority attitude. Moreover, since abnormal psychological manifestations generally bespeak the presence of more than a single causative condition there is little likelihood that the genesis of feelings of inferiority can be attributed solely to organic defects. That a definite, even though slight, positive correlation emerges from Faterson's exploratory study is important, especially when we recall the monotonous trend toward negative results apparent everywhere in our comprehensive survey of these empirical tests of asserted relationships between physical characters and mental traits. Faterson's results are also significant because if such a relationship between physical defects and neurotic symptoms can be established for presumably normal members of society there is every likelihood of discovering an even more striking relationship when pronounced neurotics are compared with normal subjects.

4. Physical Constitution and Psychotic Temperament

The concept of physical types has a long history. It seems that Hippocrates first recognized the proneness of certain physical constitutions to be susceptible to particular diseases. His "habitus apoplecticus" and his "habitus phthisicus" correspond roughly to the macrosplanchnic and microsplanchnic types respectively. A detailed account of the physical types described by various writers from Hippocrates to the present time has recently been compiled by Wertheimer and Hesketh.[15] From their detailed tabulation we have selected out certain features (presented in Table 46) which will

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[15] F. I. Wertheimer and F. E. Hesketh, "The Significance of the Physical Constitution in Mental Disease," *Medicine*, 1926, 5:375-463.

TABLE 46

Classifications of Body Types.
(After Wertheimer and Hesketh.)

	1	*2*	*3*
Hippocrates	Habitus apoplecticus		Habitus phthisicus
Walker (1852)	Nutritive beauty	Locomotive beauty	Mental beauty
Carus (1853)	Phlegmatic (region of digestive organs prominent)	Athletic (bones and muscles strongly developed)	Asthenic (narrow chest, long body, skeleton and muscles poorly developed)
Viola and, later, Naccarati	Macrosplanchnic type	Normosplanchnic type	Microsplanchnic type
Pende	Hypervegetative biotype		Hypovegetative biotype
Sigaud	Digestive type	Muscular type	Respiratory type Cerebral type
Davenport	Fleshy	Medium	Slender biotype
Kretschmer	Pyknic type	Athletic type	Asthenic type

throw light upon our discussion of the recent discoveries regarding physique and types of psychotic temperament which is to follow.

A glance at any of the columns shows a uniformity that is illuminating in understanding the terminology in this field. We are already prepared through our previous acquaintance with the Viola-Naccarati types to understand the most recent classification put forward by Kretschmer, who is dominated by the type theory of approach to physical constitution.[16] Kretschmer distinguishes the pyknic type, possessing short legs, thick neck, and a relatively large barrel-shaped trunk; the athletic type, exhibiting a more symmetrical development of limbs in relation to trunk; the asthenic type, possessing long extremities and a relatively small trunk; and the dysplastic type, composed of those not fitting into any of the three main classes.

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[16] E. Kretschmer, *Physique and Character,* Trans. by W. J. H. Sprott (Harcourt, Brace and Co., New York, 1925), pp. 1-266.

The chief measurements serving to differentiate the three types are brought together in Table 47. Not to mention the absence of hip measurements for the athletic type and the obvious typographical error regarding size of forearm of the athletic type man there are a number of rather puzzling features in this table. Why should stomach measurements for pyknic women (in whom "the magnificent fat paunch protrudes from the deep vaulted chest which broadens out towards the lower part of the body") be very much smaller than for athletic women? Why should pyknic women be taller than the asthenic type of woman? This last question

Table 47

Principal Average Measurements of Kretschmer's Three Physical Types. (After Kretschmer.)

	PYKNIC TYPE		ATHLETIC TYPE		ASTHENIC TYPE	
Physical Measurements	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Height (cm)	167.8	156.5	170.0	163.1	168.4	153.8
Weight (kilos)	68.0	56.3	62.9	61.7	50.5	32.8
Shoulder width	36.9	34.3	39.1	37.4	35.5	44.4
Chest (mean of insp. & expir.)	94.5	86.0	91.7	86.0	84.1	77.7
Stomach	88.8	78.7	79.6	95.8	74.1	67.7
Hips	92.0	94.2			84.7	82.2
Forearm (circum.)	25.5	22.4	91.5*	24.2	23.5	20.4
Hand (circum.)	20.7	18.6	21.7	20.0	19.7	18.0
Calf (circum.)	33.2	31.2	33.1	31.7	30.0	27.7
Leg (length)	87.4	80.5	90.9	85.0	89.4	79.2

* This figure is obviously a misprint in the book; otherwise we must believe that the circumference of the forearm of an athletic type man is almost as great as the circumference of the stomach of an athletic type woman.

is to the point in view of Kretschmer's claim that "pyknic women are relatively smaller than the pyknic men. Remarkably small stature, under 150 cms., is not seldom found among them." If one should translate this last sentence to mean "small stature is *frequently* found among them" then he could not account for their average height being greater than that of asthenic women. It may be easier to translate "not seldom" as meaning "seldom"!

If one becomes puzzled at the outset by the principal measurements differentiating between types he is certain to become outright bewildered when he attempts to follow the verbal descriptions of the types. They are interspersed with numerous references to specific cases, and are concerned, to a considerable extent, with distinctions not only between the three main classes but also between each of these and intermediate classifications. Asthenic and athletic features occur simultaneously in the same individual. There may also be asthenic-hypoplastic or asthenic-pyknic interference in structure, pyknic mixture, dysplastic, uncataloguable forms, etc. In speaking of certain asthenic-pyknic traits found in one and the same individual Kretschmer states, "we could reel off here, and with other types, innumerable mixtures of such a kind: there is absolutely no single criterion which cannot be varied by and combined with marks of another type."

All this is strongly reminiscent of the classification difficulties experienced in the early days of "type thinking" by experimental psychologists. For example, in classification of types of imagery.

In addition to the principal differentiating measurements noted above we are confronted with a long array of subsidiary criteria, which include seven head and face measurements, the quality and distribution of hair over the body, the texture and color of the skin, the condition of various glands, and anomalies of the sex impulse. These again are strongly reminiscent of physiognomic methodology.

Altogether we are baffled in the attempt to get hold of clear-cut and unambiguous criteria upon which we may securely depend while we employ Kretschmer's schema in classifying physical types. When quantitative measurements are given they are given in terms of averages only, unaccompanied by measures of variability. Necessary data regarding age, sex, intelligence, and social status are conspicuously wanting, so that it is impossible for other scientists to undertake, with reasonable assurance of success, to verify Kretschmer's physical classifications. In consequence, therefore, it must be kept in mind that the Kretschmer schema is limited in application to material similar to that from which it was derived, namely 260 psychopathic cases of Schwabian stock.

After all, we are not so much concerned with Kretschmer's physical types (paralleling as they do other indices of body build), as we are with his ingenious utilization of physical types in relation to the fundamental temperamental differences exhibited by the two great groups of psychotics, "circulars" or manic-depressives on the one hand, and schizophrenics or dementia praecox patients on the other.

In dealing with clinical material Kretschmer adopts a broad and elastic classification of patients. Grouped with typical cases of manic-depressive psychoses exhibiting in varying degrees either flight of ideas, psychomotor hyperactivity, and emotional exaltation or difficulty of thinking, psychomotor retardation, and emotional depression, Kretschmer includes a few cases of involution mania, senile and arteriosclerotic depression, non-lunatic "hypomania," and habitually-depressive temperaments. Similarly, along with the dementia praecox cases illustrating the typical shut-in personality he includes in his schizophrenic group occasional cases of paraphrenia, schizoid neurasthenia, psychopaths, and degenerates.

Early in his book, Kretschmer points out the relation between physique and these contrasting personality groups by showing how 85 manic-depressive cases and 175 schizophrenic cases are distributed among his physical types. The results are astounding as may be seen by reference to Table 48. The concentration of circulars among the pyknic classifications is unmistakable. Here is almost perfect verification of Naccarati's thesis that emotionality and macrosplanchny (the pyknic type) go together. On the other side, the strong concentration of the schizophrenic cases among the athletic and asthenic classifications is undeniable. Kretschmer summarizes the relationship as follows: [17]

TABLE 48

Classification of Manic-depressive Patients (Circulars) and Dementia Praecox Patients (Schizophrenes) According to Physical Type. (Kretschmer.)

	Circular	*Schizophrene*
Asthenic	4	81
Athletic	3	31
Asthenico-athletic mixed	2	11
Pyknic	58	2
Pyknic mixture	14	3
Dysplastic	..	34
Deformed and uncataloguable	4	13
Total	85	175

1. "There is a clear biological affinity between the psychic disposition of the manic depressives and the pyknic body type.
2. There is a clear biological affinity between the psychic disposition of the schizophrenes and the bodily dispo-

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[17] Kretschmer, *op. cit.*, p. 36.

> sition characteristic of the asthenics, athletics, and certain dysplastics.
>
> 3. And vice versa, there is only a weak affinity between schizophrene and pyknic on the one hand, and between circulars and asthenics, athletics, and dysplastics on the other."

Kretschmer later on warms to his subject. He generalizes beyond the limited confines of psychopathology in developing a theory of physique and character which embraces the normal personalities found in everyday life. He seizes upon the now generally accepted conclusion that there is no hard and fast dividing line between the normal and the abnormal, the latter merely exhibiting normal mental mechanisms to an exaggerated degree. This enables him to trace the transition from circular insanity to the merely cycloid temperament in which the subject exhibits the mild degrees of excitement and depression and finally to the cyclothymic personality, normal and well adjusted to the demands of everyday life. In like manner he passes from the pathological schizophrene to the schizoid who reflects the same fundamental psychological symptoms as the schizophrene in milder degree, and thence to the schizothyme, normal and well adjusted to the demands of everyday life. Kretschmer indicates the complete continuity of this transition in proposing:

> "We shall no longer look on certain types of personality as psychopathic abortive forms of certain psychoses, but vice versa, certain psychoses will figure as caricatures of certain normal types of personality. The psychoses are thus only rare exaggerated editions of large wide-spread groups of healthy constitutions" (p 208).

Individuals of cycloid temperament are characterized as being sociable, good-natured, genial, cheerful, humorous, jolly, quiet, and easily depressed. The normal cyclothymic individual exhibits these same traits to lesser degree. The schizoid temperament, on the other hand, affords a marked contrast in being unsociable, reserved, eccentric, timid, shy, sensitive, nervous, fond of nature and books, kindly, honest, indifferent, dull-witted, and silent. Again, the healthy schizothymic possesses the same traits to lesser degree.

The application of his theory to normal, healthy personalities, known intimately by him, results in attributing the following physical characteristics to persons of schizothymic temperament, "long noses, angular profiles, abnormally high middle faces, long-oval, and egg-shaped narrow facial contours, and figures which are either thin and slender, or wiry and lanky, or have marked muscular and bony relief." Persons exhibiting the cyclothymic temperament possess "the well known pyknic figures, or five-cornered contours, and the harmonious construction of the profile, with short necks, rounded limbs, and the pyknic tendency to fatness." Within the group of cyclothymes he describes, psychologically, the gay chatterbox, the quiet humorist, the silent good-tempered man, the happy enjoyers of life, and the energetic practical man. The group of schizothymes includes the polite sensitive man, the world-hostile idealist, the cold masterful natures, egoists, the dried up and emotionally lamed.

He concludes his theoretical discussions by presenting in tabular form the contrasting temperamental characteristics and their respective physical classes. This is reproduced as Table 49.

Kretschmer has boldly and ingeniously developed the outlines of a human characterology based on two contrasting temperaments and virtually two contrasting physical types. Regarded as an hypothesis arising from wide clinical practice and shrewd observation it is a challenge to us all. We must reject, modify, or accept it.

TABLE 49

The Temperaments. (Kretschmer.)

	Cyclothymes	*Schizothymes*
Psychaesthesia and mood	Diathetic proportion: between raised (gay) and depressed (sad)	Psychaesthetic proportion:—between hyperaesthetic (sensitiveness) and anaesthetic (cold)
Psychic tempo	Wavy temperamental curve: between mobile and comfortable	Jerky temperamental curve: between unstable and tenacious alternation mode of thought and feeling
Psychomotility	Adequate to stimulus, rounded, natural, smooth	Often inadequate to stimulus: restrained, lamed, inhibited, stiff, etc.
Physical affinities	Pyknic	Asthenic, athletic, dysplastic, and their mixtures

SPECIAL DISPOSITIONS

	Cyclothymes	*Schizothymes*
Poets	Realists Humorists	Pathetics Romantics Formalists
Experimenters	Observers Describers Empiricists	Exact logicians Systematists Metaphysicians
Leaders	Tough whole-hoggers Jolly organizers Understanding conciliators	Pure idealists Despots and fanatics Cold calculators

Some, indeed many, writers would have us believe that views in principle like Kretschmer's have been sufficiently verified to remove them from the realm of hypothesis. Indeed, the genial seductiveness of verbalism masquerading as causal science lures as ready victims all who have not been immunized by exposure to the rigors of quantitative, experimental, inductive, method. Berman, with deceiving rhetorical skill, weaves truth and speculation into a fascinating pattern which leads the uncritical reader to a ready belief in Endocrinological Characterology as a thoroughly established and empirically verified discipline.[18] Quantitative data, biometric analysis, and mathematical demonstration of the precise degree to which physical and mental variables are related are not to be found in the writings of men of this school. A few quotations from Miller's *Types of Mind and Body* will serve to illustrate the nonquantitative nature of this literature.[19] This book adopts the Kretschmer schema and employs the principles of type classification skilfully and effectively in delineation of psychological and physical types. With reference to physiognomic signs and symptoms of character traits we note the following:

> "The weak chin and the pale face, the square jaw and the healthy florid complexion will make or mar a man long before the subtler mental adjustments of his own life of reaction prompt us to qualify the judgment of him which we have based on his physical make-up. Not that our judgments from these premises are totally wrong. Far from it. We propose to show to what extent such judgments have a basis in fact, how physical forms do correlate with mental reactions in a broad sense, and how there is a tendency for a given physical type to react in a certain way" (p. 13).

We invite attention to the assertion of correlation, and to the claim that there is a tendency for a specified physical type to respond in a definite way. But observe that these concepts which designate quantitative relations are manipulated in verbal terms only and that one must look in vain for quantitative measurements to support them here. Or note the reliance upon common sense logical notions to support a general position, serving in turn as a springboard for more specific generalization like the following:

[18] L. Berman, *The Glands Regulating Personality* (The Macmillan Company, New York, 1921), pp. 1-300.

[19] E. Miller, *op. cit.*

"Mind divorced from Body is as incomprehensible as Body divorced from Mind. The relationship is more intimate than one of co-existence, closer than that implied in interactionism, closer even than the relationship of structure and function. . . . The study of the dynamics of his psychophysical processes will bind the two together and give us a meaningful picture of the man as a vital unity. The dynamics of his processes will include all these interactions of inner processes to outward demands which alter in divers ways the somatic organization on the one hand, and the behavior of the organism on the other" (pp. 15 and 16).

This notion is elaborated later on by asserting that inherited structure may set a limit upon neurological responses, these in turn modifying structure. In such an interplay, "Nothing seems to be lost. Environments of great variety impose themselves somehow on the structure of the body and influence behavior, and tendencies to react in certain ways are the result. Neurologically, metabolically, and psychologically the organism is one and indivisible." Thus an organismic unity is asserted, but proof in the form of specific particulars is lacking. What interpretation do such writers place upon the demonstrated relatively independent variability of physical traits such as stature, dentition, or pubescence, and mental precocity or retardation? Indeed, what interpretation can they summon for the specificity and lack of unity exhibited by the various aspects of physical growth and development itself? The present writer feels safer in retreating from the barrages of verbal attempts to solve the physical-mental enigma. Doing so, he must be content to busy himself with small sectors of the battlefield, scrutinizing carefully bits of quantitative data unearthed here and there in attempted empirical verification not of any "general problem" but of its most limited features.

To return, therefore, to a consideration of the available evidence bearing upon the Kretschmer hypothesis. One test of the worthwhileness of a scientific theory is to be found in its stimulating effect on research undertakings. Kretschmer's theory has already met this test since several attempts at verification already claim attention, and undoubtedly many more will follow.

Wertheimer and Hesketh[20] observed and measured sixty-five male patients chosen at random from the wards of the Henry Phipps Psychiatric Clinic and from the Spring Grove State Hospital. It is important to note that these patients were selected without any consideration of physique or mental diagnosis. For the most part the analyses are restricted to 11 manic-depressives and 23 schizophrenics where no question regarding correctness of diagnosis seemed to exist.

For study of the physical classification of these cases, two methods were employed. Kretschmer's criteria yielded physical type groupings. This was called the "observational method." In addition, fifty-three anthropometric measurements were taken on each patient and a new morphological index devised. This was called the "anthropometric method." This new morphological index was evolved after trying out thirty-seven different indices and finding them relatively unsatisfactory. The index of Wertheimer and Hesketh is a modification of the Viola-Naccarati morphological index, the formula being:

> Morphological Index equals leg length times ten cubed divided by the product of transverse chest diameter, sagittal chest diameter, and trunk height. The resulting ratio is then multiplied by 100. All measurements were expressed in centimeters.

Having classified each of the 65 patients into the Kretschmer physical groupings by the method of observation and having secured a morphological index for each patient,

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[20] *Op. cit.*, 391-447.

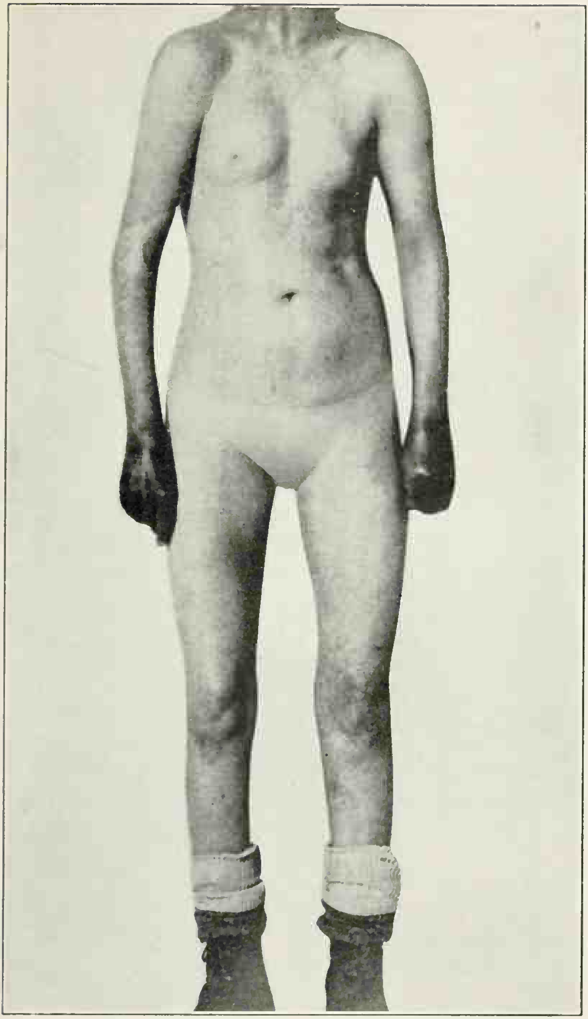

Illustration of a case of feminism in a male. Genitalia abnormally undeveloped. Reproduced by courtesy of Dr. Charles S. Bernstein, Rome, New York

on the basis of anthropometric measurements alone, they then proceed to compare the two methods in operation. A striking correlation between them was revealed. The pyknic cases had morphological indices invariably less than 255, the asthenics had indices invariably above 270. There was no overlapping of asthenic and pyknic types. The intermediate positions on the scale were occupied by pyknoid, athletic, and asthenic-athletic mixed types. All in all, a continuous distribution of morphological indices was revealed. Thus, the data afford a clear demonstration that Kretschmer's physical types are not types at all from a biometric point of view. Rather, there appears to be a continuous gradation from low indices to high indices with a majority of the cases clustering around the middle values. In other words, morphological index is distributed normally like every other measurable biological trait. Pyknic type and asthenic type turn out to be merely extremes on a single, continuous scale of measurement in accordance with modern biometric expectations. The most frequent condition, of course, turns out to be "mixed" or dysplastic, with the athletic a close second. This discovery will greatly facilitate further experimentation with Kretschmer's hypotheses because it simplifies his cumbersome descriptions of body types and permits straightforward quantitative treatment of the type ratio derived from body measurements as a continuous variable.

We come now to the crux of the Wertheimer-Hesketh experiment. Is there a close correlation between morphological index and psychotic temperament? Eleven unquestionable manic-depressive cases yield an average index of 233.2 whereas 23 unquestionable schizophrenics have an average index of 280.7. There is some overlapping. The comparison is obscured by the factor of age because the index usually becomes lower with increased age and the manic-depressives were on the average some ten years older than the schizophrenics. However, the six manic-depressives aged 29 years or more have an average index of 199.1 as contrasted with an average index of 260.3 for 12 schizophrenics of the same age range. Table 50 summarizes the relationship in terms of body type (classified on the basis of observation). It is apparent there is a close connection between manic-depressive psychosis and the pyknic or pyknoid body build. The schizophrenic cases are distributed more widely over the whole range of body types and are not definitely confined to the extreme asthenic type.

TABLE 50

Showing the Percentage Distribution of Manic-Depressives and Schizophrenes According to Kretschmer's Body Types. (After Wertheimer and Hesketh.)

Body Type	*Clear Manic-Depressives*		*Clear Schizophrenes*	
	All ages N = 11	Age 29+ N = 6	All ages N = 23	Age 29+ N = 12
Pyknic	45.5	66.6	4.3	8.3
Pyknoid	36.4	33.3	13.0	25.0
Athletic	9.0	0	26.1	16.7
Asthenic-athletic mixed	0	0	34.8	25.0
Asthenic	0	0	17.4	16.7
Unclear	9.0	0	4.3	8.3
Total	99.9	99.9	99.9	100.0

One must not accept the evidence in Table 50 as conclusive proof of Kretschmer's theories because, after all, the number of cases involved is pitifully small from a statistical point of view. Conclusions drawn from eleven clear cases of manic-depressive psychosis can not be regarded as final in the present uncertain state of our knowledge of body types. In view of the severity of our general strictures above we ought to be the first to admit that the evidence is at least highly suggestive. Certainly, it is sufficiently positive to encourage more extensive investigations.

We must keep in mind, however, that this evidence throws no light whatsoever upon the existence of a similar relationship between body build and temperament among the mentally normal. The subjects in this study represent extreme deviations from the normal. Indeed we may legitimately suppose that such a close relation as seems to exist between the manic-depressive temperament and the pyknic body form will not be found when the normal cyclothymic personality becomes the object of quantitative measurement and morphological classification. Certainly the results for the extreme schizophrenics are sufficiently obscure to warrant little hope of finding that any well defined body form is characteristic of the normal, adjusted schizothymic.

Mohr and Gundlach ventured to seek confirmation of Kretschmer's theories among the convicts in Joliet, Illinois.[21] They selected, on the basis of body form, 89 subjects of whom 19 were asthenics, 26 athletics, and 44 pyknics. A series of mental tests were then administered to these groups. The most striking difference between the groups was shown in scores on the Army Alpha intelligence test, the asthenics averaging 96.5 points, the athletics 79.2, and the pyknics 57.9. This relationship was confirmed by a negative correlation of — .34 between Army Alpha score and a morphological index obtained by dividing the sum of the circumferences of chest, abdomen, and hip plus weight, by height. (This index is the reciprocal of that used by Naccarati and by Wertheimer-Hesketh, hence the obtained correlation is negative.) Since pronounced age differences exist between these three groups of subjects (the pyknics were older by about 6 years than the other two groups), and since score in Alpha is probably negatively correlated at least to a slight degree with age beyond 30 or 35 years of age, it is possible that part of the differences between the groups is a function of age rather than body build. Moreover, the significance of the association between morphological characteristics and mental inferiority in the pyknics is greatly lessened if not negated entirely if we allow for the fact that a larger proportion of the pyknic than of the other groups have Southern European ancestry. Indeed, failure to match the three morphological groups on the basis of age, nationality, and social status makes comparisons between them very hazardous.

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[21] Geo. J. Mohr and Ralph H. Gundlach, "The Relation Between Physique and Performance," *J. of Exper. Psychol.*, 1927, 10:117-157.

The authors interpret the differences between the three groups in speed of tapping, cancellation, speed of writing, etc., as evidence that asthenic subjects show more schizothymic tendencies and pyknic subjects more cyclothymic tendencies. There appears to be little or no convincing justification for such a conclusion. Indeed, progress in differentiating temperaments is seriously handicapped by the absence of reliable and valid psychological tests of such dispositions as the schizothymic and cyclothymic. It requires a generous faith to believe that the series of simple psychomotor tests employed by Mohr and Gundlach even begin to meet this pressing need.

An additional attempt to verify the Kretschmer schema is reported by Dr. Farr of the Pennsylvania Hospital.[22] He first reviews a preliminary study based upon anthropometric measurements and indices of 25 males, 15 with schizoid reactions and 10 with affective reactions. He concludes:

> "Typical 'asthenic' types occurring in dementia praecox, and equally typical 'pyknic' types occurring in manic-depressive psychosis, were shown. In this small series the findings seemed to corroborate Kretschmer's ideas, particularly with respect to the frequency of the typical asthenic

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[22] C. B. Farr, "Bodily Structure, Personality and Reaction Types," *Am. J. of Psychiatry,* 1927-28, 7:231-244.

habitus in schizothymia, and its comparative rarity in cyclothymia" (p. 233).

His more elaborate study, reported in the same article, included the same 25 males plus 45 females (11 schizoid, 16 affective, 13 miscellaneous, and 5 without psychosis). Fifty anthropometric measurements were taken and these were charted graphically for each case. "The figures suggest a rather definite association of seclusive and schizoid personalities with the slender, relatively elongated types—often with dysplastic features—and of the affective personalities with intermediate or definitely thick-set physiques" (p. 236). However, Dr. Farr expresses certain reservations by pointing out that his results involve outstanding exceptions and numerous questionable correlations so that anthropometry is to be looked upon as suggestive rather than diagnostic. The conservative position taken by Dr. Farr is shown by his final conclusion, "The charts and tables are based on too few cases to justify any final conclusions, particularly as the criteria used in differentiating habitus, personality, and reaction types are all highly subjective" (p. 242).

An attempt to differentiate between 50 manic-depressive psychotics and 50 dementia praecox patients by use of the Naccarati morphological index is reported by Shaw.[23] The results seem to be in line with conventional expectations, the average morphological index of the dementia praecox cases being 572.3 as contrasted with an average of 402.4 for the manic-depressives. All of the patients with morphological indices between 250 and 340 were manic-depressives whereas all having indices between 680 and 880 were schizophrenes. The author asserts that the distribution of morphological indices is bimodal (the modes lying at 400

[23] F. C. Shaw, "A Morphologic Study of the Functional Psychoses," *State Hospital Quarterly*, 1924-25, 10:413.

and 570), a fact which would strikingly emphasize the significance of the findings. Unfortunately, no measures of variability are given so that it becomes impossible to determine the amount of overlapping. It is perhaps noteworthy that the range of morphological indices for these pathological cases is so extended, the usual range for college students being in the neighborhood of 350 to 675.

Altogether, the theory of differences in body build between two contrasting types of temperament seems to have been established for pathological cases only. Even here, the need is urgent for additional studies employing adequate statistical methods and careful controls requiring that manic-depressives and schizophrenics be matched on the basis of age, sex, race, nationality, previous education, occupation, and social status. Along with such searching investigations and preliminary to the verification of the asserted relationship for normal subjects psychiatrists and psychologists are under obligation to coöperate in producing a satisfactory scale for measuring cyclothymic and schizothymic temperamental characteristics. This field of research is of fundamental importance in developing the science of human characterology.

5. Biochemical Approaches to Personality

In view of the noteworthy success of Cannon and others in laying bare neurological, physiological, and particularly the biochemical mechanisms underlying such emotional states as pain, rage, hunger, and fear, we may include in this chapter a glimpse at recent research attempts to establish a biochemical basis for certain personality traits.[24]

The idea that specific behavior traits might ultimately be explained largely if not completely by biochemical formulas is far from being novel. Actual research attempts in this direction were under way a quarter of a century ago by such workers as Folin, Schaffer, and Hill.[25] The more recent work of Ludlom and his associates at the University of Pennsylvania demonstrates a differential body chemistry with reference to the two contrasting pathological conditions of excitement and mental confusion.[26] In the excited type of insanity, alkaline saliva coupled with alternatingly acid and alkaline urine, perspiration and feces was found. In the confused type, a generally acid condition was disclosed. The attention of psychologists was definitely focused upon this type of approach by Starr's demonstration that a lethargic type of stammerer could be differentiated from an excitable type of speech defective on the basis of a chemical analysis of saliva.[27] In the former group, distinctly acid saliva was found whereas in the latter group the saliva was either neutral or alkaline.

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[24] W. B. Cannon, *Bodily Changes in Pain, Hunger, Fear, and Rage*, rev. edition (D. Appleton and Company, New York, 1929), pp. 1-404.

This kind of work has not been restricted solely to definitely pathological subjects. Crile, on the basis of his rich clinical experience, propounds an elaborate view of the chemical basis of life.[28] Needham goes even further in the direction of affirming a belief in the possibility of expressing all mental phenomena in chemical terms.[29] His cited article is both general and specific. It contains a careful philosophical formulation of biochemical determinism supported by a review of fifty references to empirical evidence for the chemical foundations of mental reactions. Needham, armed with evidence, does not hesitate to predict that biochemical research eventually will disclose in detail the cerebral chemistry associated with mental states. As an example of its far-reaching possibilities he foresees a day when biochemists may prove that "a deficiency of sulphatide phosphorous and a high oxidation-reduction potential in a certain area of the cerebral cortex is invariably associated with the creation of great poetry." He sketches in outline a program of biochemical research which shall ultimately demonstrate a functional relationship between individual differences in body chemistry and individual differences in mental characteristics and behavior.

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[25] Folin, O., Schaffer, P., and Hill, L. A., "Some Metabolism Studies with Special Reference to Mental Disease," *Am. J. of Insanity*, 1904, 60:702.

[26] Ludlom, S. De W.: "Physiologic Psychiatry," *Med. Clin. of North Amer.*, 1918, 2:895.

[27] Starr, H. E., "The Hydrogen-Ion Concentration of Mixed Saliva Considered as an Index of Fatigue and of Emotional Expression, and Applied to a Study of the Metabolic Etiology of Stammering." *Am. J. of Psych.*, 1922, 33:394-418.

[28] G. W. Crile, *Man—An Adaptive Mechanism* (The Macmillan Company, New York, 1916), pp. 1-379; also *A Bipolar Theory of Living Processes* (The Macmillan Company, New York, 1926), pp. 1-405.

[29] J. Needham, "Lucretius Redvivus: The Hope of a Chemical Psychology," *Psyche*, 1927, 7:3-19.

The most significant piece of research in this field, using normal subjects, was done by Dr. Gilbert J. Rich whose training in psychology and medicine enabled him to combine the research techniques of both disciplines.[30] In brief, he obtained personality ratings on normal subjects, made biochemical tests upon certain features of bodily metabolism of the same subjects, and then computed a series of coefficients of correlation between the personality ratings and the biochemical determinations. Three groups of subjects were employed: 18 male graduate students in psychology, 39 undergraduate members of a fraternity, and a group of 303 children who passed through the behavior clinic of the Institute for Juvenile Research in Chicago. In the case of the graduate students, ratings were obtained from two instructors and also by having them rate one another. The traits rated were good-naturedness, perseverance, leadership, aggressiveness, and excitability. Each of the undergraduates was rated on the same traits by five of his fraternity brothers. Intelligence test scores were available for these students. The 303 children were rated on the traits good-naturedness, aggressiveness, and excitability by the psychological examiner, the physician in charge of the physical examinations, the psychiatrist, and the laboratory technician. The I.Q. for each child was available.

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[30] G. J. Rich, "A Biochemical Approach to the Study of Personality," *J. of Abn. and Soc. Psychol.*, 1928, 23:158-175; also G. J. Rich, "Body Acidity as Related to Emotional Excitability," *Arch. of Neur. and Psychiatry*, 1928, 20:589-594.

Each undergraduate and graduate student contributed three samples of saliva and three 24-hour samples of urine at weekly intervals. Partial control over diet was exercised through suitable instructions to the subjects. The biochemical analyses in the case of each of the clinic children were confined to blood specimens secured in the course of the routine Wassermann tests.

Space forbids detailed statement of all of the conditions surrounding the experiment. Rich himself indicates in his published articles that various sources of error inhere in the biochemical measurements as well as in the personality ratings. Indeed, so many sources of error are present as almost to preclude the possibility of obtaining positive results. Since, then, this is a type of research in which negative results would not prove the absence of relationship between chemical factors and personality ratings, any positive results found take on added significance.

The coefficients of correlation between each of the chemical determinations and each of the personality traits are shown in Tables 51, 52, and 53.

In view of the small number of subjects among the two groups of college students, it is natural immediately to question the significance of low negative and positive coefficients of correlation. One device to discover whether Tables 51 and

TABLE 51

Coefficients of Correlation Between Saliva and Urine Biochemical Analyses and Personality Ratings—39 Undergraduates. (After Rich.)

	Good-natured-ness	*Perse-verance*	*Leader-ship*	*Aggres-siveness*	*Excit-ability*	*Intel-ligence*
Saliva, hydrogen-ion concentration (pH)	+.03	+.07	−.09	+.09	+.28	+.29
Free acid (Total)	+.05	−.03	−.09	−.31	−.25	−.14
Free acid (per 100 c.c. urine)	−.15	−.15	−.24	−.19	−.02	−.04
Free acid per body weight (kg)	+.01	+.02	−.25	−.43	−.38	−.21
Acidity (Total by formol titration)	+.02	−.12	−.11	−.31	−.06	+.06
Acidity (Formol per 100 c.c. urine)	−.24	−.22	−.32	−.25	+.11	+.17
Acidity per body weight (kg)	−.03	−.05	−.32	−.49	−.22	−.08
Total acid (Total)*	+.04	−.08	−.12	−.32	−.17	−.03
Total acid per 100 c.c. urine	−.21	−.23	−.27	−.20	+.09	+.11
Total acid per body weight (kg)	−.02	.00	−.33	−.55	−.35	−.16
Creatinine (Total)	+.17	−.12	−.03	−.26	−.10	+.01
Creatinine per 100 c.c. urine	−.19	−.26	−.37	−.31	+.08	+.19
Creatinine per body weight (kg)	+.13	+.04	−.04	−.29	−.24	−.32
Phosphorus (Total)	+.26	−.12	+.06	−.12	−.11	−.43
Phosphorus per 100 c.c. urine	−.07	−.24	−.30	−.22	+.04	−.17
Phosphorus per body weight (kg)	+.20	−.06	−.09	−.22	−.18	−.51
Volume of urine excreted	+.32	+.21	+.42	+.13	−.21	−.24
Body weight	+.08	−.09	+.30	+.23	+.23	+.23

* Total acidity was determined by adding the free acid determination by direct titration and the acidity determination by the formol titration. See original articles in *J. of Abn. and Soc. Psychol.* for detailed references to biochemical methodology.

Table 52

Coefficients of Correlation Between Saliva and Urine Biochemical Analyses and Personality Ratings—18 Graduate Students. (After Rich.)

	Good-natured-ness	*Perse-verance*	*Leader-ship*	*Aggres-siveness*	*Excit-ability*
Saliva, hydrogen-ion concentration (pH)	+.09	+.24	+.10	+.51	+.45
Free acid (Total)	+.38	−.07	+.20	.00	−.26
Free acid (per 100 c.c. urine)...	−.10	−.23	−.11	−.01	+.01
Free acid per body weight (kg).	+.27	−.09	+.11	−.13	−.14
Acidity (Total by formol titration)	+.36	+.02	+.20	−.24	−.27
Acidity (Formol per 100 c.c. urine)	.00	−.08	−.01	−.01	+.07
Acidity per body weight (kg)...	+.26	+.03	+.11	−.31	−.17
Total acid (Total)*............	+.43	−.01	+.26	−.14	−.29
Total acid per 100 c.c. urine....	−.07	−.15	−.07	−.03	+.01
Total acid per body weight (kg)	+.32	−.03	+.12	−.26	−.16
Creatinine (Total)	+.17	−.17	+.27	+.13	−.24
Creatinine per 100 c.c. urine....	−.28	−.16	−.02	+.32	+.15
Creatinine per body weight (kg)	+.17	−.34	+.15	−.14	−.23
Phosphorus (Total)	+.34	−.39	−.03	.00	−.29
Phosphorus per 100 c.c. urine....	−.28	−.34	−.32	−.04	−.02
Phosphorus per body weight (kg)	+.28	−.34	−.07	−.19	−.24
Volume of urine excreted.......	+.28	−.01	+.16	−.25	−.29
Body weight	+.04	+.07	+.13	+.37	−.09

* Total acidity was determined by adding the free acid determination by direct titration and the acidity determination by the formol titration. See original articles in *J. of Abn. and Soc. Psychol.* for detailed references to biochemical methodology.

Table 53

Coefficients of Correlation Between Biochemical Analyses of Blood and Personality Ratings—303 Behavior Clinic Children.* (After Rich.)

	Good-naturedness	*Aggres-siveness*	*Excit-ability*	*Intelli-gence (I.Q.)*
Creatinine	+.08 (154)	−.04 (144)	−.21 (154)	−.01 (159)
Alkali Reserve	−.07 (100)	−.26 (89)	−.05 (100)	−.03 (164)
Inorganic Phosphorus ...	−.21 (184)	−.14 (171)	+.03 (184)	+.06 (201)

* Below each coefficient of correlation there is given in parentheses the number of children involved in the computations.

52 represent merely a collection of correlation coefficients whose magnitudes are determined for the most part by chance is to correlate corresponding columns in the two tables. The writer has done this with the result that corresponding columns of correlation coefficients turn out to be roughly concordant. The correlations (rank difference method) are as follows: good-naturedness, + .58; perseverance, + .40; leadership, + .40; aggressiveness, + .48; and excitability, + .56. These coefficients are all positive and of fair magnitude indicating that chance factors have not been solely operative. Biochemical personality relationships are shown to exist to a measurable degree between these two independent series of observations.

Rich's conclusions, tentatively stated after an extensive discussion of details are as follows:

1. Acid urine and saliva tend to characterize the less excitable persons, whereas the more excitable individuals tend to exhibit neutrality or alkalinity.
2. Acidity as measured by formol titration and high alkali reserve in the blood seems to characterize the less aggressive subjects, and vice versa.
3. Creatinine in the blood and its excretion in the urine seem to be related inversely to emotional excitability.
4. No clear-cut relationship between phosphorous metabolism and personality traits is demonstrated although the evidence suggests that definite relationships might be shown through further experimentation.

As Rich recognizes and explicitly states, it would be premature to regard the results of this experiment as definitely established. Scientific caution dictates qualified acceptance of the results. At the same time, it seems fair to conclude that Rich has opened up a fruitful field of research, one which should be intensively cultivated by those possessing the essential specialized equipment in biochemistry and psychology.

6. Psychological and Anthropometric Measures of Masculinity

Havelock Ellis has popularized the notion that there is an intimate relation between masculinity in behavior and masculinity in physical sex characteristics.[31] He bases his major claims upon observed characteristics of effeminate men and masculine women. Moreover, a number of experimental studies, chiefly with animals, afford some justification for such a notion, since variation in physiological sex functioning has been shown to cause corresponding variations in physical, morphological, and behavior secondary sex characteristics.[32]

It is generally accepted that masculinity and femininity are based in large part upon differential internal secretions, sex hormones, and that these two terms are relative in so far as there exists a continuous gradation from an extreme degree of masculinity to an extreme degree of femininity.

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[31] Havelock Ellis, *Psychology of Sex*, vol. II, ch. IV and IX.

[32] See W. H. Howell, *Text-Book of Physiology* (W. B. Saunders Company, Philadelphia, 1919), especially pp. 893-895. With reference to Steinach's experiments, Howell states: "This observer reports further remarkable experiments in which young males (rats, guinea pigs) were first castrated and then had transplanted under the skin or in the peritoneal cavity the ovary from a female of the same species. Under such conditions the graft of the ovary takes, and unlike the grafted testicle both the reproductive cells and the interstitial cells survive. In such animals the secondary male characteristics do not develop, his genital organs remain infantile; he exhibits, on the contrary, the female characteristics, as shown by his size, the character of the hair, and especially by the development of mammae and nipples. So far as the external characteristics are concerned the animal is completely feminized, and Steinach states that such an animal is sought by the male as though it were a true female. It would follow from these experiments that the internal secretion of the interstitial cells in the ovary and in the testis has each its specific influence in guiding the development of the sexual characteristics, one causing the formation of male, the other of female characteristics" (p. 894).

Furthermore, these traits may vary within each sex to such an extent as to warrant the use of the concept of sex inversion. The accompanying photograph illustrates a case of a male exhibiting "feminism."

There is a generally accepted notion, too, that both the differentiation of the sexes and divergences from normal may be readily diagnosed by reference to physical secondary sex traits such as characteristic body form, distribution of hair on the face and body, muscular development, and voice quality (especially pitch). These secondary sex characters evidence themselves concurrently with and shortly after the onset of puberty. Furthermore, such physical traits are assumed to be intimately interwoven with, or indeed to be basic in the causation of, the masculine and feminine mental traits. The writings of Havelock Ellis, W. I. Thomas, Louis Berman, and E. Kretschmer emphasize this point of view.

Kretschmer [33] in describing the physical characteristics of "elongated eunuchoids" emphasizes their relatively large hip measurements. Again, in describing masculinism among his female subjects he stresses the diagnostic significance of shoulder-hip measurements:

> "The proportions of the trunk, particularly, are characterized by a remarkable disproportion between the breadth of the shoulder and the hips. Here, just as with strongly-built men, the low hip measurements lag behind a high shoulder measurement to a very marked degree." [34]

With this general hypothesis in mind, an attempt to measure the relationship between psychological and anthropometric measures of masculinity was undertaken, under the writer's direction, by Ulvin.[35] The results reported were derived from measurements of 100 University of Minnesota freshman women and 100 Minnesota freshman men. The shoulder-hip ratio was taken as the anthropometric measure of masculinity since a pronounced sex difference in this respect is known to exist after the onset of puberty, for which reason it is regarded as a secondary sex character induced or at least not uninfluenced by the sex hormones. As psychological measures of masculinity, the Stanford Play Interest Questionnaire[36] (instructions modified for use with adults) and a Knowledge of Sports Test designed by Pressey and Stephens[37] at Ohio State University were employed. Both of these measures yield striking sex differences which are unrelated to intelligence, and it seemed reasonable to assume that a male college student who exhibits a very limited knowledge of sports and indicates childhood preferences for characteristically feminine play activities might reasonably be labeled effeminate, whereas a female college student who possesses a wide knowledge of sports and indicates childhood masculine play preferences might reasonably be labeled "masculine."

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[33] *Op. Cit.*, pp. 67-69.

[34] *Op. Cit.*, pp. 70-73.

[35] Gennette M. Ulvin, "A Study of the Relationship of Psychological and Anthropometric Measures of Masculinity," M. A. Thesis 1927, on file in the University of Minnesota Library.

The Stanford Play Interest Questionnaire is scored in such a way as to yield a masculinity index. Terman demonstrated the existence of a marked sex difference for both the group of gifted children and a control group containing children of average I.Q.'s. These differences are strikingly shown in Table 54. The mean score for the gifted boys is 15.2 and for the gifted girls 11.4. The mean for the control boys is 14.9 and for the control girls 11.2. Not only is there a marked sex difference in average score but also there is very little overlapping of scores for the two sexes, as may be seen from Table 54.

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[36] L. M. Terman, *Genetic Studies of Genius*, vol. I, ch. 14.

[37] Willie Stephens, "An Investigation of the Interests of College Students in the Field of Sports," M.A. thesis, Ohio State University, 1922.

TABLE 54

Masculinity Ratings of Control and Gifted Children, by Sex. (From Terman, 1925.)

	CONTROL GROUP				GIFTED GROUP			
	BOYS		GIRLS		BOYS		GIRLS	
Rating	*No.*	*Per Cent.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
20	1	0.6	..	..	1	0.3	..	..
19	1	0.6	..	..	3	1.0	..	..
18	4	2.5	..	..	6	2.1	..	..
17	14	8.7	1	0.6	33	11.4	1	0.4
16	34	21.2	..	..	76	26.2	1	0.4
15	40	24.8	1	0.6	92	31.7	6	2.6
14	34	21.2	7	4.0	62	21.4	16	6.9
13	31	19.2	17	9.6	8	2.8	23	9.9
12	1	0.6	56	31.6	6	2.1	54	23.3
11	..	..	39	22.0	2	0.7	69	29.8
10	1	0.6	36	20.3	..	..	34	14.7
9	..	..	15	8.5	..	..	20	8.6
8	..	..	5	2.8	..	..	4	1.7
7	..	..	..	..	..	..	4	1.7
6	..	..	..	..	..	..	..	..
5	..	..	..	..	1	0.3	..	..
Total	161	100.0	177	100.0	290	100.0	232	100.0
Mean	14.9	..	11.2	..	15.2	..	11.4	..
S. D.	1.5	..	1.5	..	1.5	..	1.7	..

Reference to the mean scores also emphasizes the fact that the masculinity index is a matter of sex and not of intellect. This is further apparent from the correlations between the preference indices of the 90 activities derived for each of the four groups of subjects:

	r	*PEr*
Gifted boys vs. control boys	+ .83	± .02
Gifted girls vs. control girls	+ .82	± .02
Gifted boys vs. gifted girls	+ .20	± .07
Gifted boys vs. control girls	+ .18	± .07
Control boys vs. control girls	+ .35	± .06
Control boys vs. gifted girls	+ .22	± .07

It is highly significant that in every case where a correlation is computed on the basis of an inter-sex comparison the r's are low whereas the correlations between the two groups within each sex are high.

The Stanford psychologists seemed to feel that these masculinity ratings were reflecting some sort of innate sex difference. The fact that, contrary to popular opinion, the gifted boy was not effeminate in his play interest, but was rather inclined to be more masculine than the boy of average intelligence was stressed as throwing light upon the mental traits and characteristics of the precocious boy. There seemed to be some evidence that these masculinity ratings could be regarded as indices of secondary sex characteristics since the mean masculinity ratings of the control girls became lower (i.e., more feminine) after the age of fourteen years whereas the ratings of the gifted girls became lower two years earlier. Presumably the onset of puberty caused the play interests of the girls to become more feminine.

As employed in our present study the Stanford Play Interest Questionnaire was given in its entirety, substituting modified instructions which called for the recording of preferences in accordance with what those preferences were remembered to have been at the age of twelve years. This procedure involved two assumptions, (1) that memory is to be trusted, and (2) that the masculinity or femininity of a person remains relatively constant from the age of twelve to the beginning of the college course. Striking sex differences were obtained among our college freshmen on this questionnaire, the details in line with those obtained by Terman and his co-workers. Only one per cent. of the freshman women obtained masculine indices higher than the mean of the men and none of the freshman men obtained masculine indices lower than the mean of the women. (See Table 55). The means of the Play Interest Indices of the Stanford control girls and the Minnesota college women (reporting from memory) are very similar, and the same can be said for the means of the Stanford control boys and of the Minnesota college men. These findings suggest that our assumptions regarding applicability of the questionnaire to college freshmen were sufficiently valid to warrant its use in the investigation.

The Knowledge of Sports Test likewise reveals striking sex differences among college students which could not possibly be related to the factor of intelligence. As developed by Pressey and Stephens, the test included twenty-seven groups of five questions each, covering thirty-two different sports. For use in the present study, the test was revised to include only those fifteen groups of items which showed sex differences at least ten times the probable error of the difference originally obtained at Ohio State University. The revised test yielded marked sex differences when applied to Minnesota freshmen, only 5 per cent. of the men obtained scores lower than the mean of the women and only 2 per cent.

TABLE 55

Masculinity Ratings (Play Interest Indices) of University Freshman Men and Women. (From Ulvin, 1927.)

Rating	*Freshmen Men*	*Freshmen Women*
16	15	..
15	36	1
14	37	4
13	12	7
12	..	24
11	..	29
10	..	30
9	..	5
Total	100	100
Mean	15.0	11.6
S. D.	0.87	1.2

of the women obtained scores which exceeded the mean of the men. (See Table 56.) The difference between the means of the two groups was 13.4 times the standard deviation of the difference and hence is a statistically certain difference.

The reliability of each of the two psychological measures of masculinity was determined by correlating the sums of the scores on the odd numbered items with the sums of the scores on the even numbered items for each sex separately. The reliability coefficients turned out to be +.90 for the men and +.82 for the women in the Sports Information Test, and +.73 for the men and +.81 for the women in the Play Interest Index. Thus both measures are sufficiently consistent to warrant confidence in them as measuring devices.

TABLE 56

Distribution of Scores of University Freshman Men and Women in Sports Information Test. (From Ulvin, 1927.)

Score	*No. of Men*	*No. of Women*
45–48	1	
41–44	5	
37–40	8	
33–36	22	
29–32	11	
25–28	16	3
21–24	8	6
17–20	10	9
13–16	8	21
9–12	7	20
5– 8	4	32
1– 4	0	9
Total	100	100
Mean	27.2	11.8
S. D.	10.8	5.8

Of course, we can have no assurance of having isolated and measured masculinity and femininity as psychological traits. In view of the fact that these two measures intercorrelate to the extent of only +.20 for the men and +.26 for the women it is inadvisable to employ such a term as "psychological masculinity." For this reason we prefer a designation referring to masculinity in recreational activities revealed through a play interest questionnaire and through an actual test of sports knowledge. Which of the two measures of masculinity in recreational activities is the more valid index of masculinity or femininity can not be inferred at the present time. Tentatively, one would be inclined to accept the knowledge of sports index as more significant since it measures knowledge possessed at the time of testing.

Great care was taken to insure reliability and comparability of the anthropometric measurements.[38] Both persons actually taking these measurements by way of preliminary training measured the same groups of 50 men and 50 women, obtaining two sets of three each (repetitions) of the four hip and shoulder measurements required for the experiment proper. Reliability coefficients ranged from +.88 to +.97 for these measurements. Correlations between the measurements obtained by the two experimenters ranged from +.60 to +.91, seven of the eight correlations being +.80 or more. These precautionary determinations demonstrated that the obtained measurements were highly reliable and that the measurements obtained by the two experimenters were comparable.

Two shoulder measurements (biacromial and bihumoral) and two hip measurements (intercristal and intertrochanteric) were obtained from each subject. From these various measurements shoulder-hip ratios were determined. The shoulders of the freshman men are decidedly wider than the shoulders of the freshman women. Analysis of these data keeping height constant demonstrated that the men's shoulders were also relatively wider. Thus greater shoulder width for men is shown to be a function of sex and not of greater stature or size. There is less absolute difference between the sexes in hip width but when height is kept constant the men are found to have relatively narrower hips. The large amount of sex differentiation disclosed by these two measurements is shown in Tables 57 and 58.

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[38] Miss Genette Ulvin measured the freshman women and Mr. Gordon Riley measured the freshman men having been trained in the limited anthropometric techniques here employed by Dr. Richard Scammon of the Anatomy Department.

TABLE 57

Distribution of Shoulder Width Measurements (Height Held Constant) of University Freshman Men and Women. (From Ulvin, 1927.) Note: The shoulder measurements are expressed as ratios of bihumoral width to height.

Shoulder Measurement	*No. of Men*	*No. of Women*
.260–.267	1	
.252–.259	0	
.244–.251	1	
.236–.243	5	
.228–.235	14	
.220–.227	29	4
.212–.219	24	17
.204–.211	16	28
.196–.203	8	31
.188–.195	0	10
.180–.187	0	7
.172–.179	2	3
Total	100	100
Mean	.222	.205
S. D.	.01	.01

TABLE 58

Distribution of Hip Width Measurements (Height Held Constant) of University Freshman Men and Women. From Ulvin, 1927.) Note: The hip measurements are expressed as ratios of intertrochanteric width to height.

Hip Measurement	*Men*	*Women*
.218–.221	..	2
.214–.217	1	1
.210–.213	..	2
.206–.209	..	7
.202–.205	2	13
.198–.201	1	14
.194–.197	4	21
.190–.193	7	21
.186–.189	9	9
.182–.185	20	6
.178–.181	25	1
.174–.177	16	1
.170–.173	11	1
.166–.169	1	1
.162–.165	2	
.158–.161	..	
.154–.157	..	
.150–.153	1	
Total	100	100
Mean	.183	.197
S. D.	.010	.010

Since all available data revealed marked sex differences for the two psychological measures of masculinity in recreational activities and for the sevearl physical measures, we were prepared to demonstrate a close relationship between the psychological measures and the physical measures. If both types of measures are true reflections of secondary sex characters then a correlation between them would seem to be inevitable. Moreover the correlation must be present *within each sex group.*

To determine the exact amount of correlation existing between these two variables, ninety correlations were computed by Miss Ulvin. To specify, fifteen physical measurements and ratios were available for correlation purposes, and each of these was correlated for the two sexes separately with the Play Interest Index, the Sports Knowledge Test, and with the average of Play Interest and Sports Knowledge combined. These ranged from —.15 to +.23 with the median at +.02. Since each correlation was based upon 100 cases, all of the probable errors are rather large, namely about ±.07. Sixty-two of the 90 correlations fall between the limits of +.07 and —.07 indicating that chance factors only are operative in about two-thirds of the data. Detailed analysis of all ninety correlations with special attention directed to those instances where a positive correlation greater than +.07 appeared, failed to reveal significant trends toward definite association. Apparently the conclusion is obligatory that no reliable or significant relationship exists between these psychological and anthropometric measures of so-called masculinity-femininity. The relationship is absent whether we consider the correlation between the fifteen physical measures and Play Interest Index or between these fifteen physical measures and the Sports Knowledge Test or between these physical measures and an average of Play Interests and Sports Knowledge.

In investigations like this one it is always advisable to determine, if possible, whether any additional obscure factors may surreptitiously mask the real relationship. The factors of age and intelligence were statistically eliminated. When isolated and held constant by the partial correlation technique no evidence of their effective influence was forthcoming.

It was not possible similarly to isolate the influence of previous social experience and social environment. Had this been feasible, a significant positive relationship between the psychological and anthropometric measures of masculinity might have emerged. However, Ellis and prevailing popular opinion hold to the belief that masculinity or femininity asserts itself in spite of environmental factors. Our negative results raise the presumption of a relationship at best too weak to manifest itself in the face of compensating environmental influences.

A negative outcome is always to be interpreted with great caution. It is entirely possible, of course, that more valid measures of masculinity as a psychological trait will yield positive results. Again, it may be that our physical measures of masculinity were not well chosen. Conceivably, a battery of tests of psychological masculinity may yield a close positive correlation with a carefully selected group of physical signs of masculinity such as voice, skin texture, development and distribution of hair on the body and more elaborate measurements of physical secondary sex characters. These considerations dictate avoiding any dogmatic denial of significant relationship. We may be permitted however, to conclude that these results cast at least tentative doubt upon popular and pseudo-scientific assertions regarding an unambiguous and easily demonstrated relationship between physical and psychological masculinity. Finally, it would seem more reasonable to believe, at the present time, that masculinity in recreational pursuits is more largely a result of training and environment than of glandular or hormone differences.

7. Summary

Obscure relations between the functioning of the glands of internal secretion, physical traits, and non-intellectual components of personality may and probably do exist. However, available evidence fails to substantiate the easy generalizations put forth by phrenologists, physiognomists, and graphologists. Even the recent attempt of Naccarati to demonstrate a morphological basis for the neurotic temperament likewise fell short of empirical verification when put to a searching and thoroughgoing examination.

Faterson showed a definitely positive though slight relationship between physical defects and attitudes of inferiority, thus substantiating in part the Adlerian concept of "organ inferiority" as basic in the constitution of the neurotic temperament. Some experimental evidence points to a morphological basis for contrasting psychotic conditions, although it is premature to apply Kretschmer's criteria to members of the "normal" population. Positive results have rewarded some attempts to demonstrate a biochemical correlate of certain personality traits. Rich's findings are doubly significant because they were secured from normal subjects. The Adler-Faterson approach, the Kretschmer schema, and the biochemical attack, open up fields of research of fundamental importance in developing a science of human characterology. Ulvin's attempt to demonstrate a significant relation between physical measurements supposedly reflecting secondary sex characters and masculinity in recreational pursuits, although negative, opens up another type of approach to the baffling problem of the relation between physique and non-intellectual aspects of personality.

Since the glands of internal secretion presumably play an important rôle both with respect to physical traits and to emotional and temperamental behavior the inference that there exist important relationships between them will not be downed. At the present time, however, the notions of men like Berman should be regarded merely as hypotheses for investigation, not as established scientific facts. Progress in this field will be slow, but sufficiently encouraging results have been secured from the small number of quantitative studies so far completed to justify optimism for the future. What we need is less endocrinological speculation in psychology and more psychological experimentation in the field of endocrinology. To this end, coöperative research should be fostered. Psychologists, psychiatrists, anthropometrists, and endocrinologists must pool their research techniques for a unified attack on the obscurities which lie beneath even the most simple and sure generalization in this challenging field of science.

Chapter VIII

SUMMARY AND CONCLUSIONS

1. Trend of the Evidence

OUR detailed survey of available quantitative evidence has demonstrated that prevalent notions regarding the intimacy of the relationship between physical traits and intellect have been greatly exaggerated. Search in the realm of gross anatomy for a physical correlate of intellect has yielded uniformly negative results. It appears that such structural characteristics as height and weight are correlated only slightly with intelligence, narrowly defined. Even measurements of head size and shape are found to be relatively independently variable with respect to intellect, and skeletal development measured by precise X-ray photography yields either zero or low correlations with intelligence. The same may be said of dentition. Physiological development, measured in terms of pubescence, is found to be relatively unrelated to mental development, and so are complicated morphological indices of body build.

A more surprising finding is the negative trend of the evidence with respect to mental correlates of ordinary physical defects and certain presumably deleterious physical conditions. In addition, there is the disappointing outcome of glandular therapy as a predicted panacea for mental deficiency. The evidence seems quite clear that mental development proceeds in relative independence of physical condition except when disease processes or injuries directly attack the central nervous system, especially the higher centers.[1]

The suggestion is frequently encountered that physical traits may be found associated to a greater extent with temperament than with intellect. Even here, however, little optimism is justified. An intimate connection between body build and temperament has not been disclosed. The positive findings of Kretschmer, Wertheimer and Hesketh, Farr, and Mohr and Gundlach are restricted to definitely pathological material. For example, Mohr and Gundlach in their recent study of 550 Illinois native-born white male criminals found only a slight relationship between body build and intelligence.[2] Their commendably cautious attitude is a good example for others: "Interpretation of the results in terms of cyclothymic and schizothymic temperaments seems impossibly complex; . . . The tendencies found previously, based on 89 selected men, are not entirely borne out by the inadequate data available for the unselected criminals" (p. 103).

2. Bearing of Assembled Evidence on Current Views

The reader who began this book without definite preconceptions and who has followed the discussion to this point may well be in a frame of mind to imagine that the negative trend of the evidence was after all what was to be expected. In this case he may easily believe that we have been guilty of setting up a straw man for the sole purpose of proceeding to its easy demolition. The writer has attempted, however, through appropriate citations in various portions of the book, to show that extravagant notions have been widely held by prominent and competent scientists, not only in the past but today as well. It is necessary to read only the Proceedings of the Third Conference on Research in Child Development called by the National Research Council in 1929 to realize that exaggerations persist.[3] For example, Dr. C. B. Davenport, speaking with reference to an assumed parallelism between mental and physical growth said:

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[1] A recent contribution with additional evidence on this point is the monograph by E. E. Lord, "A Study of the Mental Development of Children with Lesion in the Central Nervous System," Genetic Psychol. Monog., 1930, 7:365-486.

[2] G. J. Mohr and R. H. Gundlach, "A Further Study of the Relation Between Physique and Performance in Criminals," *J. Abn. and Soc. Psychol.*, 1929, 24:91-103.

> "I think that is a very fundamental thing,—that development at a particular age is, within limits, not confined to special parts of the body, but is general, and we have to look for and to find a parallelism between mental and physical development. I know that efforts which have been made in the past to find the relationship between these two sets of phenomena have failed to show a significant correlation. I think, however, that that may very well be due to limitations of the method employed. I think that for the most part the majority of us have sought to find the correlation between the mental development as measured by mental tests and growth in stature, merely.
>
> On the other hand, if one looks over the whole field and considers all of the physical changes which are associated with particular ages of development, and if one tabulates them together and considers the result, then one can get a physical quotient corresponding somewhat with the intelligence quotient, and one finds there is a very high correlation between them, exceeding five or six times its probable error.
>
> So I believe there is a very fundamental principle, namely, that you cannot separate the physical and mental development" (p. 280-281).

The reader will note that Dr. Davenport believes development at a particular age to be general. This is unexpected in view of his own earlier demonstration that different segments of the body contributing to total stature are independently variable, thus proving that stature is not inherited as a "unit character."[4] In view of this demonstration of the specificity of growth factors within the restricted field of stature, it is difficult to understand how such diverse aspects of growth as intellect and physique can still be thought of as being intimately tied together in a general growth pattern.

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[3] "Proceedings of the Third Conference on Research in Child Development," pub. by National Research Council, Div. of Anthrop. and Psychol., Com. on Child Development, 1929, I:1-227; II:228-351.

Davenport's belief that a combination of physical traits will yield "a very high correlation" with I.Q. also has little to recommend it. The evidence already reviewed, especially in Chapters IV and V, is definitely opposed to such a view. The reader will recall that Naccarati entertained the same notion when he stated that the physical correlate of intellect would be found not in any single physical trait but in a combination of many elementary physical traits. But his own results proved inconsistent and subsequent workers failed to verify his hypothesis. In similar manner Gates demonstrated that no method of combining physical traits could be found which would yield high correlations between a "compound physical index" and intellect.

The facts in the preceding chapters of this book should go a long way toward counteracting the view that there is a functional unity between mind and body. Analytical science breaks down primitive notions of unity where independent variability of parts actually exists. But, surprisingly enough, writers, who are schooled in the methods and principles of genetics, find it difficult to preserve the analytical attitude when it comes to the problem at issue here. For an example, note the inconsistency of Popenoe in his recent book entitled *The Child's Heredity*.[5] In one part of his book he recognizes the validity of the negative trend of the evidence: "By and large there is little relation between anatomic or, as one might say, static characters and mental traits" (p. 185). In other portions of the same book he falls back on the notion of unity: "Philosophically, since body and mind are one, it follows that any alteration in one is an alteration in the other" (p. 187). "The fundamental fact, which is axiomatic, that that mind will function best which is part of the most perfect and efficient body—since body and mind are inseparable, as the Ancient Greeks recognized better than some moderns" (p. 154). "But in so far as a child's level of intellect represents more or less fully his native endowment, it is evident that this endowment is a general one, linking together every function of the individual. . . . The association between degrees of gross bodily efficiency and degrees of strictly intellectual efficiency is sufficient evidence, if any were needed, that most or all of the genes in the fertilized egg contribute to the establishment of the final level of intellect" (p. 155).

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[4] See chap. II for statement on this point derived from C. B. Davenport, "Inheritance of Stature," *Genetics*, 1917, 2:313-381.

[5] Paul Popenoe, *The Child's Heredity* (Williams & Wilkins Company, Baltimore, 1929).

Popenoe's inconsistencies aside, it is clear that he tacitly accepts (or perhaps not so tacitly) the view that physique and intellect are intimately and inextricably bound up in a causal nexus. In the naturalistic world one can not conceive of intellect existing apart from a physical body; but this conception does not imply that gross anatomy is the physical basis of intellect. Attention must be shifted from such structural characteristics as height, anatomical development, dentition, body build, and even size and shape of head to the central nervous system,—especially the cortex cerebri. There is every reason to believe that improved methods of studying the functional relationship between nervous system and behavior will disclose the long-sought-for physical basis of intellect.[6]

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[6] K. S. Lashley, *Brain Mechanisms and Intelligence* (University of Chicago Press, 1929). For studies on correlation between neurological

An analogy may assist us in particularizing the nature of the difficulty. Designers of automobiles can be said to produce artificially a high positive correlation between the size and weight of the body of an automobile and the horse power capacity of the engine. In similar manner they put out automobiles with a high positive correlation between the engine power and artistic stream-line effects, quality of upholstery, effectiveness of shock absorbing mechanisms, the number and quality of accessories, etc. Even though high positive correlations of this kind could be demonstrated, the ordinary person would not be misled into thinking that there is a *causal* relationship between external appearances and the efficiency of the engine. The buyer of a second hand car would be foolish if he were to purchase on the basis of body build and upholstery without noting the condition of the engine. An automobile mechanic is never misled by metaphysical notions regarding the integrity and unity of the automobile. To discover the seat of trouble or to test the efficiency of an automobile requires that attention center immediately upon specific parts, number of cylinders in the engine, condition of spark plugs and pistons, timing, etc.

The essential point is that the mechanic, faced with a machine where there is a high positive correlation between body build and engine power, senses the lack of causal relationship and directs his attention solely to the essential physical correlates of power. But scientists dealing with man, even in the face of low correlations between physical traits and intellect, find great difficulty in thinking about the human organism without being influenced by metaphysical notions of unity. We need more of the mechanic's matter-of-fact attitude in biological science.

Failure to face the facts of physical development and

organization and behavior see G. E. Coghill, *Anatomy and the Problem of Behavior* (Cambridge University Press, 1929).

mental development as relatively independently variable is betrayed in many ways. It comes out in expressions of dissatisfaction with chronological age as the basic factor in interpreting the intellectual significance of mental level. We are offered mental age as an indicator of brightness or dullness when interpreted in terms of physiological development rather than chronological age, a notion likely to result in proposals to substitute some measure of physical or physiological development for C.A. in the I.Q. formula. As noted in earlier chapters, what amounted to a suggestion that physiological age be substituted for chronological age in the I.Q. formula was made by the late Bird T. Baldwin. That this notion persists is evidenced by the recent proposal of Baldwin's successor as Director of the Iowa Child Welfare Station, Dr. George D. Stoddard, who declared in the Third Conference on Child Development:

> "There is no particular reason, especially in very young children, why chronological age should determine everything. As a matter of fact, since we know that a difference in ante-natal term of as much as two or three weeks may make a difference of several months in post-natal development, we may be certain we have introduced an error. If all these struggles to get some meaning from physical development have any reference to mental devlopment, they should lead to an improvement over chronological age in terms of years. If we can build up a quantitative rating which we could put under mental age we could do very well without chronological age, or we could have two I.Q.'s: the present I.Q. which does not take into account physiological difference, and another I.Q. which we might call his *potential I.Q.* A child five months old chronologically but only four months old physiologically (if we could build up the latter concept) with an I.Q. of 100 may really be a very intelligent child. He may be simply competing at too high a level" (pp. 276-277).

Enough evidence has already been cited to expose the weakness of such proposals. The substitution of physiological age for chronological age can not be legitimate unless or until investigation demonstrates that the former is more intimately related to intellect than the latter. In spite of such expressed dissatisfaction with chronological age, the abilities involved in intelligence test performance reflect the maturation and growth of the central nervous system under ordinary conditions of stimulation and this inner growth is, roughly, a function of elapsed *time*. Time, as expressed in chronological age, is the one readily obtained objective measure. It should not be superseded without clear demonstration of the superior advantage of some other and rival common denominator employed as a base for interpreting mental performance.

The writer has dwelt at this length on the bearing of the obtained evidence upon current views because the whole history of the subject reveals appearance and reappearance of similar ideas in one form or another. The belief that there is necessarily an intimate connection between physical and mental traits is "easy to scotch but hard to kill." Furthermore, he believes that many of the cited investigations were obviously conducted for the purpose of collecting substantiating evidence rather than as impartial inquiries designed to ascertain the true status of the relationship between physique and intellect.

3. Theory of Unique Traits

Without doubt the negative trend of the evidence reviewed has important implications for theories of the nature and organization of personality. The findings clearly support the *theory of unique traits* as formulated by Thorndike, Kelley, Toops, Hull, and others.[7]

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[7] See D. G. Paterson, R. M. Elliott, L. D. Anderson, H. A. Toops, and E. Heidbreder, *Minnesota Mechanical Ability Tests* (University of Minnesota Press, Minneapolis, 1930), especially ch. II, "The Theory of Unique Traits," and ch. XII, "Mechanical Ability as a Unique Trait."

In brief, the theory of unique traits is that personality adjustments reflect, in varying proportions, the operation of relatively independent traits. In the Minnesota Mechanical Ability investigation it was demonstrated that I.Q., Mechanical Ability, and Physical Agility are unique, each with respect to the other. In other words, these three aspects of behavior, when isolated and measured with a high degree of reliability, were found to yield low intercorrelations, so low in fact as to warrant, to a degree, acceptance of the theory of unique traits. Furthermore, height was shown to be unique not only with respect to I.Q., but also with respect to Mechanical Ability tests, success in vocational shop courses, and agility. Nothing in our survey of the available literature on physique and intellect contradicts this finding; in fact, the trend of the evidence supports it.

Progress in personality evaluation and analysis will be furthered by the discovery of additional identifiable and measurable traits unique among themselves and unique with respect to the unitary traits already isolated and measured.

4. Present Status of the Problem

The investigations reviewed in this book have been confined to the relation between intelligence and temperament on the one hand and physical traits and physical condition on the other. We have accepted the criteria employed during the past forty years of research, feeling that nothing was to be gained from endless discussions regarding appropriate indices of physical development, of mental development, or of temperament.

Sufficient studies have been completed to warrant generalization at the present time so far as these traditional indices are concerned. The negative generalization seems to rest upon a fairly solid foundation of ascertained facts. Rather than to revert in review to previously cited work the writer prefers to cite two additional important references, one of them fresh from the printer.

Gesell in his recent book, *Infancy and Human Growth,* describes a case of partially successful therapy consisting of administering thyroid extract to an infant presumably suffering from cretinism. No miraculous effects of glandular therapy are in evidence. Gesell also presents preliminary data regarding the relationship between malnutrition in infancy (rickets) and mental growth.[8] Malnutrition, even when it occurs in infancy, does not cause mental retardation. Gesell's interpretation harmonizes with the previously stated conclusion that nature has thrown strong safeguards, as it were, around the nervous system so that it enjoys considerable immunity even against the supposedly deleterious influences of faulty or impoverished nourishment.

Hirsch, in a study just reported, finds a correlation of +.08 ±.042 between cephalic index and I.Q. derived from six annual measurements by means of the Otis tests.[9] These negative results are especially valuable since the 240 subjects are exceptionally homogeneous with respect to nationality (chiefly of Anglo-Saxon stock), and age (all were twelve years old when the head measurements were taken), yet were heterogeneous with respect to social-economic status, having been selected from three widely differing sections of the city of Nashville, Tennessee. This social-economic heterogeneity might have introduced a spuriously high correlation between head shape and I.Q. Absence of appreciable correlation under such circumstances merely adds to the trend of evidence disclosed in Chapter III.

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[8] A. Gesell, *Infancy and Human Growth* (The Macmillan Company, New York, 1928).

[9] N. D. M. Hirsch, "An Experimental Study Upon Three Hundred School Children Over a Six-Year Period," Genetic Psychol. Monog., 1930, 7:487-549.

Though it is unlikely that additional investigations will do more than merely corroborate the accumulated evidence already at hand, we must beware assuming that what can be said to-day will remain for long the last word on the subject. Scientific generalizations must always be regarded as provisional. Improved statistical methods of analysis, innovations in the field of physical indices, invention of new modes of mental and physical diagnosis, all of these may at any time lead to positive findings contrary to those to which we now subscribe. Karl Pearson, in a lecture delivered to members of the teaching profession in England in 1924, made a statement which holds for to-day and to-morrow:

> "When we come, however, to associate mental and bodily characters, we find no correlation whatever of prognostic value. . . . It is, however, too early yet to assert that no measure of bodily functioning will turn out to be of service in diagnosing intelligence. Men of science will continue to inquire, but thus far our only answer can be that to predict intelligence of an individual you must test it directly, or measure it in the immediate ancestors of the individual" (p. 405-406).[10]

It should be kept in mind that the evidence we have been citing has come almost wholly from investigations of either adults or children of school age. This constitutes an admission that our knowledge concerning the relation between physical development and mental development in infancy and early childhood is as yet fragmentary. In the early years of life, physical growth and mental growth are presumably proceeding at their maximum acceleration. For this reason and in order to close this gap in our knowledge it is imperative that investigations, similar to those reviewed in this book, should be undertaken at the pre-school level.

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[10] K. Pearson, "On Our Present Knowledge of the Relationship of Mind and Body," *Annals of Eugenics*, 1925-26, 1:382-407, Issued by the Francis Galton Laboratory for National Eugenics, University of London, Cambridge University Press.

5. Suggested Lines for Further Research

The examination and synthesis of a field of research inevitably suggests innumerable problems which await solution. It may be in place here to point out some of the more pressing ones in the field of physique and intellect.

The most conspicuous gap in our knowledge has just been mentioned, namely, the relation between physical development and mental development at the pre-school level. Sufficiently reliable methods of gauging mental status at this age have been developed or are being developed to warrant thoroughgoing experimentation. Admittedly, worthwhile results can be obtained only after these methods have achieved satisfactory validity and consistency. Another difficulty encountered will be in the adequate control of chronological age. Since physical and mental growth are extremely rapid during infancy and early childhood, it will be necessary to exercise unusual care in experimentally holding chronological age constant (this means down to very narrow limits). The temptation to use partial correlation methods rather than experimental control in dealing with chronological age must be resisted, though the only alternative is the more laborious and time consuming method of testing an adequate number of children at each specified stage of development. Control of the age factor at the pre-school level must be far more rigid than that usually required in investigations with older children, since small age differences in the early years are almost certainly equivalent to much larger age differences later on. Studies of mental growth in relation to height, weight, body build (if this means anything in infancy), anatomical development, dentition, and size and shape of head should receive the first attention. Incidentally, it would be of value to ascertain the relation of these physical indices to motor abilities.

A most challenging problem awaiting solution, and one not immediately concerned with the relation between physique and intellect, is the determination of the physical basis of vigor, or stamina, or robustness. The need for undertaking investigation here is forcibly brought out by the study of Gates which revealed that no single aspect of physical status is a dependable index of physical fitness, a fact of the utmost importance to pediatricians, child welfare workers, and directors of physical education. The traditional reliance upon one or two indicators of physical status as a basis for appraising vigor and stamina is unscientific and pitifully inadequate. We can hardly expect current practice to improve before a searching coöperative research is organized to determine a valid index of physical fitness. It will be necessary to discover the best specific physical factors to include and the proper weights to assign to each. It is encouraging to note that the American Child Health Association is inaugurating and supporting a genuine research program which gives promise of solving some of the problems involved in physical diagnosis.[11] Results already secured demonstrate the unsatisfactory character of physicians' ratings of nutritional status and indicate that a preliminary selection of physical measurements when properly weighted yields diagnoses in quantitative terms which are far superior to those rendered by physicians on the basis of the usual physical examination. Objective testing methods and multiple-ratio techniques will revolutionize the present basis of physical diagnosis. Biometric methodology is demanded. Perhaps the physician of the future will be as thoroughly trained in mathematical statistics as the physician of the present day is in chemistry, anatomy, and physiology.

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[11] R. Franzen, "Physical Measures of Growth and Nutrition, Am. Child Health Assoc.," School Health Research Monographs, 1929, 2:1-138.

No one could deny that we need to push the investigation of physical defects and physical condition in relation to intelligence. Carefully controlled measurements of the efficiency of hearing by the use of improved audiometers should be correlated with adequate measurements of intelligence. Numerous claims have been made to the effect that hearing defects occasion pedagogical and mental retardation, but we still are without well controlled quantitative investigations in which the influence of age, sex, nationality, and social-economic status are disclosed. The demand is imperative for studies of the mental after effects of various diseases and injuries such as birth injuries, infectious diseases accompanied by high temperatures, spinal meningitis, infantile paralysis, etc. The least ambiguous results will be secured where it is possible to obtain I.Q.'s before as well as after onset of disease or injury. It is not unreasonable to expect or at least to hope, that those now engaged in the practice of glandular therapy will secure accurate measurements of I.Q. before and after treatment. The same may be said of experiments on the mental effects of oral hygiene over short and over long periods of time. Carefully controlled studies to determine the possible mental benefits arising from scientifically prescribed diet should be prosecuted. The effect of ultra-violet ray treatment on mental alertness and mental growth should also be ascertained on as extensive a scale as possible. In short, uncounted problems in public health work and private medical practice wait only upon the requisite coöperation between competent psychologists and those trained in scientific medical research.

Research efforts in this direction are necessarily tentative and pioneering as is shown at many points in our survey of the relation between physique and temperament. But the fact that there are theoretical reasons for anticipating that definite positive relationships will be discovered between physical traits and various non-intellectual aspects of personality should act as an incentive to vigorous experimentation. We urged that methods be devised for a more thoroughgoing testing of Kretschmer's hypotheses within the limits of the definitely pathological material. Of even greater interest would be the attempt to test empirically the accuracy of the Kretschmer classifications within the limits of normal variations in temperament.

With each definite advance in personality measurement will come the opportunity for seeking physical correlates. Mention should be made of Olson's ingenious utilization of the method of time-sampling whereby from systematic observation of tics in children it becomes possible to obtain a quantitative index of "nervousness" for each child.[12] The data tend to show that these quantitative indices may be regarded as roughly reflecting the degree to which any given child is "neurotic." Of immediate interest is the discovery that body build is related to these indices of nervousness,—underweight children at each age tend toward nervousness; so do overweight children in at least three of the six age groups studied; normal weight children tend to exhibit the fewest signs of nervousness. Perhaps a more striking correlation between physique and nervousness might be found if the Olson technique in its most elaborate form were applied to larger numbers of children with the definite aim of combining a variety of physical measurements into a single physical index of nervousness.

Hope of signal advances in all these fields seems to depend upon recognizing the advantages inherent in coöperative programs of research. Psychologists alone can not hope to cope effectively with many of the suggested problems. Throughout his survey of the research literature which gave rise to this book the writer has been impressed with those instances in which psychologists have collaborated with representatives of other disciplines in a unified attack on problems falling between two or more fields of study. To raise questions regarding the relation between physical traits and mental traits is in its mere statement to emphasize the borderland nature of the problem. Coöperation between psychologists and various specialists: dentists, health officials, pediatricians, epidemiologists, endocrinologists, biochemists, anthropologists, anatomists, psychiatrists, etc., must be sought and obtained if these varied problems are to be attacked systematically, energetically, and resourcefully.

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[12] W. C. Olson, *The Measurement of Nervous Habits in Normal Children* (The University of Minnesota Press, Minneapolis, 1929).

6. Limitations of Previous Research Studies

The specific limitations and shortcomings of certain investigations have already been set down in detailed criticism. At this time it is intended merely to summarize some of the more outstanding weaknesses and to clarify the main issues from a methodological point of view.

The most general defect observable in investigations of the relationship between physical traits and mental traits has been the adoption of the statistical method of group comparison as against the method of direct correlation. The former method, even when properly safeguarded, can never do more than indicate the *existence* of a probable relationship. Only by use of the latter method can the *degree* of the relationship be determined.

In the use of the method of group comparison numerous pitfalls are encountered. Failure to determine the statistical probability that an obtained difference is not due to mere sampling errors is perhaps the most obvious. A far more serious difficulty is encountered when standards derived from one group are applied to another group without insuring comparability of the groups in respect to such factors as age, sex, social-economic status, or nationality. In many cases differences are discovered and attributed to a functional relationship between two traits when in reality the observed differences are produced by some irrelevant factor such as nationality which should have been rigidly controlled. The difficulty may arise where an investigator relies naively upon standards or norms which are established without rigid description of the nature of the groups from which they were derived for normative purposes. To avoid these gross errors it will be necessary to develop a multiplicity of norms for mental test performance and for physical measurements. Judicious selection from this store of valid norms of the norms appropriate to each particular investigation will be necessary.

Even in the absence of such a multiplicity of norms, rapid progress will be made if investigators can bring themselves to pay far more attention than is customary to the obligation of defining the major characteristics of the groups compared. Significant advance in the exercise of such controls has been made in a series of investigations now under way in the Institute of Child Welfare at the University of Minnesota.[13] In addition to the usual control of age, sex, and nationality, the principle of *systematic sampling* of children truly representative of the various social-economic strata in the community has been adopted. This has been accomplished by determining for Minneapolis, on the basis of U. S. Census data, the distribution of paternal occupations. These have been grouped into six categories in accordance with occupational intelligence standards derived from the Army intelligence test results and the Barr-Taussig scale. This grouping of occupations permits definite description of the social-economic composition of groups of children or adults selected for any particular study. Furthermore, workers in other localities desiring to repeat any of the investigations conducted in Minneapolis will be able to determine the extent to which their samplings agree with or diverge from the original experimental groups. Upon the adoption of this and similar methodology as standard practice it will be assured that the literature on mental and physical growth will not thereafter contain so many puzzling inconsistencies as have appeared in the past.

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[13] F. L. Goodenough, "The Kuhlman-Binet Tests for Children of Pre-School Age" (The University of Minnesota Press, Minneapolis, The Institute of Child Welfare Monograph Series, 1928, 2:1-146).

Another defect frequently found in the reports of those who have relied upon the method of group comparisons is the failure properly to interpret statistically significant differences between obtained means or averages. The mere demonstration of such differences seems to content many workers. Frequently there is no clear statement regarding the scientific or practical significance of the differences, though without this the findings are well-nigh meaningless. Furthermore, many workers naively assume that a statistically certain difference implies the existence of marked relationship between the factors studied, whereas the fact is that statistically significant differences may be obtained even though the factors are correlated negligibly. For example, the reader will recall Porter's study of St. Louis school children which showed that the average weight of nine-year-old boys differed greatly from school grade to school grade (the pedagogically accelerated being heavier on the average than the pedagogically retarded) yet the actual correlation between weight and grade location was found to be only +.06.

The tendency to utilize obtained differences between means to prove the existence of a definite relationship between measured traits should be curbed. The method of direct correlation should be substituted. Bi-serial *r*'s, contingency coefficients, tetrachoric correlations, and correlation ratios are available for types of data not readily handled by the more orthodox Pearsonian *r*. When these statistical methods are used more frequently, it will result in a more conservative interpretation of findings. The temptation is great to suggest the desirability of declaring a moratorium on the use of the $\frac{D}{PE_{diff}}$ formula in all investigations of the relation between mental and physical traits. Parenthetically, the use of this formula in investigating sex differences and similar problems should likewise be discouraged.

A word of caution is also in order with respect to the use of the partial correlation technique. The application of this formula to data derived from limited numbers of cases is hazardous. The zero order correlations entering into the partial correlation should be established with a minimum of variability due to sampling errors; hence the insistence upon large numbers of subjects. Of still more importance is the need for controlling factors through experimental procedures rather than by means of statistical manipulation. For example, since one can not be sure that the magnitude of the relationship between height and I.Q. would be identical at successive age levels, the control of the age factor by partial correlation technique might be faulty in yielding a sort of blurred or averaging effect. A further advantage of experimental control lies in the demand for many more subjects in order that the relationship for each age group may be determined with minimal probable errors. No one would deny that increasing the numbers of cases in psychological investigations, assuming equal care in the conduct of experiments, is prerequisite to the attempt to determine the precise degree of relationship between variables.

7. Bearing of the Evidence on the Problem of Individual Differences in Intellect

The existence of enormous individual differences in intellect has long been recognized. Of late years their range, incidence, and other aspects have been the subject of quantitative demonstration by means of standardized tests of abstract intellect (Stanford-Binet I.Q., etc.). Although expert opinion is by no means unanimous with reference to many technological problems involved in intelligence measurement, still there is substantial agreement regarding the range of individual differences. When the question of their causation is raised, however, we find differences of opinion which in general reflect degrees of adherence to, or denial of, the rôle of biological heredity in human behavior.[14]

Presentation and discussion of the evidence bearing upon the "nature vs. nurture" controversy is certainly beyond the scope of the present book. Nevertheless, it is incumbent upon us to point out the bearing of the negative evidence on certain lines of argument frequently advanced by environmentalists who insist that individual differences in intellect arise chiefly from differences in environmental opportunities.

There is the view that environmental influences exert a powerful effect in moulding the physical and mental development of the child, development in both aspects responding to the same environmental agencies. It is held that those features of the environment which retard physical development retard mental development as well; likewise that nurture which is favorable to accelerated physical growth leads also to accelerated mental growth; and that an intimate connection between physique and intellect results. However, this expectation definitely fails to be realized in the general finding that physical characteristics and intelligence are relatively independent.

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[14] Contrast the trend of the interpretation in "Nature vs. Nurture," *Twenty-seventh Yearbook of the National Society for the Study of Education*, vols. I and II (Public School Publishing Company, Bloomington, Illinois, 1928), with ch. VIII, "The Psychometric Approach," in W. I. Thomas and D. S. Thomas, *The Child in America* (Alfred A. Knopf, New York, 1928).

Another environmentalist argument stresses the importance of physical condition as a determinant of normal mental development. Adherents of this view emphasize the deleterious effect on mental efficiency wrought by malnutrition, adenoids, and diseased tonsils, minor glandular disorders such as endemic goiter, hookworm, intestinal toxemia, and dental caries. Indeed they insist that the harmful mental consequences of such conditions are self-evident. But the evidence opposes this view and denies that individual differences in intellect can legitimately be attributed to such physical factors or conditions, or to ordinary physical defects.

It is difficult, almost to the point of impossibility, to reconcile these findings with the most insistent claims advanced by the environmentalists. But although the evidence demonstrates that individual differences in intellect are not due to ordinary physical defects and poor physical condition, still we are not thereby warranted in denying the possible potence of cultural aspects of environment. However, the overthrow of environmental claims with respect to physical defects and physical condition does undermine the nurture hypothesis to just that extent. Pearson, taking his stand on the fact that intelligence is only negligibly correlated with a wide array of physical traits and physical condition, does not hesitate to go further: "Intelligence as distinct from mere knowledge stands out as a congenital character. Let us admit finally that the mind of man is for the most part a congenital product, and the factors which determine it are racial and familial; *we are not dealing with a mutable char-*

acteristic capable of being moulded by the doctor, the teacher, the parent or the home environment. These may provide the material upon which it can act, and give a welcome scope for its activities, but they do not create it" (p. 124).[15] (Italics added.)

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[15] K. Pearson and M. Moul, On the Intelligence of the Alien Jewish Children, *Annals of Eugenics*, 1925-26, 1:56-127.

Index of Names

Abernethy, E. M., 50 f., 137, 142 f., 149 f.
Adler, Alfred, 227-230, 267
Allen, B. M., 26
Anderson, J. E., 77
Anderson, L. D., 276
Almack, J. C., 159
Aristotle, 4
Arlitt, A. H., 210
Arnold, Felix, 42
Ayres, L. P., 177 f., 202

Babcock, Marjorie E., 80, 83, 110, 122
Baldwin, Bird T., 27-29, 45-48, 66, 121, 128 f., 275
Bayerthal, J., 97 f., 102
Bean, R. B., 147 f.
Beik, Arthur K., 147 f.
Berman, Louis, 214, 239 f., 256, 267
Berry, R. J. A., 102, 104-106, 108
Betts, G. H., 11
Beyer, H. G., 41 f.
Binet, Alfred, 90-93, 102, 124
Blackford, Katherine M. H., 214-218
Blanton, S., 176
Boas, F., 37
Bocker, E., 133
Brooks, Fowler D., 70
Burks, Barbara S., 9

Cannon, W. B., 248
Carter, T. M., 14, 132 f.
Carus, 232
Cattell, J. McKeen, 70
Cattell, Psyche, 151, 153-156
Christopher, W. S., 41
Cleeton, G. U., 4, 8, 219
Coghill, G. E., 274
Collins, S. D., 43, 115, 181, 202
Conn, J. C. M., 208 f.
Cornell, W. S., 176, 202
Crampton, C. W., 13, 125, 127, 138-141, 143, 145, 147, 156
Crile, G. W., 249

Davenport, C. B., 26, 78, 232, 271 f.
Dawson, S., 208 f.
Dayton, N. A., 62-64
Dearborn, Walter F., 130
De Busk, B. W., 42
Dickson, Virgil, 16
Dixon, 122
Doe-Kulmann, L., 143-146
Doll, E. A., 58-61
Dowd, H. L., 174

Elliott, R. M., 276
Ellis, Havelock, 255 f., 266
Evans, Alice L., 218 f.
Eyerich, G., 100 f., 107 f.

Farr, C. B., 246 f., 270
Faterson, Hanna Fay, 227-231, 267
Fernald, M. R., 192 f., 210
Folin, O., 249
Foster, W. L., 141
Fowler, O. S., 81 f.
Fox, Edna J., 190 f.
Franz, S. I., 222
Franzen, R., 281
Freeman, F. N., 14, 132 f.

Gall, F. J., 82
Galton, Francis, 5, 24 f., 70, 84-86, 107
Garrett, H. E., 14, 164, 167, 220, 222-225
Gates, A. I., 14, 50 f., 133, 135-137, 172, 272, 281
Gesell, A., 145, 147, 278

Gilbert, J. A., 30, 35, 37, 39, 52
Gladstone, R. J., 95 f.
Glueck, Bernard, 229
Goddard, H. H., 55-58, 210
Goodenough, F. L., 285
Goring, Charles, 6-8
Gundlach, Ralph H., 245 f., 270

Hallowell, D. K., 207
Hankins, F. H., 80, 112
Hardy, M. C., 174, 187
Harrow, B., 26
Heidbreder, Edna, 12, 165, 227, 276
Heron, David, 170-172, 202
Hesketh, F. E., 231 f., 242-245, 270
Hill, L. A., 249
Hippocrates, 231 f.
Hirsch, N. D. M., 278
Hoefer, C., 174, 187
Hollingworth, H. L., 8, 223
Hollingworth, Leta S., 68 f.
Holt, L. Emmett, 62
Howell, W. H., 255
Hull, Clark L., 114 f., 218 f., 276
Hunt, J. L., 14, 173
Huntington, 122

Jackson, C. M., 77
James, W. W., 13
Jastrow, Joseph, 4
Jelliffe, S. E., 229
Johnson, Buford J., 14, 165, 173

Karn, M. N., 194
Kelley, Truman Lee, 5, 206, 276
Kellogg, W. N., 14, 167, 224 f.
Kempf, G. A., 43, 115, 181, 202
Kenagy, H. G., 218
Kendall, E. C., 188
King, Irving, 141 f.
Knight, F. B., 4, 8, 219
Kohnky, E., 201, 203
Kretschmer, E., 161, 214, 232-246, 256, 267, 270, 283

Lashley, K. S., 273
Lee, Alice, 69, 89, 103, 107
Lewy-Guinzburg, R. L., 163
Lincoln, E. M., 14, 173
Lind, John E., 229
Loewenfeld, L., 100 f., 107 f.
Lord, E. E., 270
Lowe, G. M., 186 f.
Lowell, Frances, 129-131, 148
Lowenz, M. A., 69
Ludgate, Katherine E., 215-218
Ludlom, S. DeW., 249

MacDonald, Arthur, 37-40, 74, 86-89, 107, 110, 118 f.
McElhannon, J. C., 14, 132
McGregor, A. L., 157
McHale, Kathryn, 49
Mallory, J. N., 179, 181
Mead, C. D., 57 f.
Miller, E., 213, 240
Mohr, George J., 245 f., 270
Moul, Margaret, 50 f., 121, 171 f., 205 f., 290
Mulligan, J. H., 108, 112 f.
Murdoch, K., 48, 112

Naccarati, S., 14, 160-168, 192, 214, 220-227, 232, 236, 242, 245, 247, 267, 272
Needham, J., 187 f., 249 f.
Newcomb, Arthur, 214, 218
Nicholls, E. E., 175
Nielson, I. L., 195
Norsworthy, Naomi, 52-54

Olesen, R., 192 f.
Olson, Willard C., 283

Paterson, Donald G., 195, 215-218, 276
Paulsen, Alice, 197
Pearl, Raymond, 99-101, 108, 117
Pearson, Karl, 50 f., 69, 73, 98-101, 107, 112, 114 f., 120 f., 171 f., 205 f., 279, 289 f.
Pechstein, L. A., 157
Pende, 232
Perkins, Frances J., 149-152
Peterson, F., 94 f.
Pintner, R., 58, 195
Pitts, A. T., 13
Popenoe, Paul, 272 f.
Porter, W. T., 26, 30-35, 39, 41-43, 74, 85 f., 107, 139, 141, 286

Porteus, S. D., 80, 83, 102-114, 122
Potter, H. W., 189
Prescott, D. A., 14, 130 f.
Pressey, S. L., 257, 260
Pryor, J. W., 125
Pyle, W. H., 43

Reed, R. W., 108, 112 f.
Rich, Gilbert J., 250-254, 267
Riley, Gordon, 262
Rogers, M. C., 183-187
Roller, R. D., Jr., 181
Röse, C., 73, 96 f., 107, 119 f.
Rotch, T. M., 124-127
Ruml, Beardsley, 206

Sandwick, R. L., 178 f., 183
Scammon, Richard E., 175, 262
Schaffer, P., 249
Schlapp, Max, 188
Severson, S. O., 127
Shaw, F. C., 247
Sheldon, William H., 166, 225 f.
Sherman, Elsie B., 114 f.
Shuttleworth, G. E., 52
Sigaud, 232
Simon, Th., 90
Smedley, F. W., 42
Smillie, W. G., 196 f.
Sommerville, Richard C., 70, 113 f., 120 f., 168
Sorokin, P., 72 f., 117, 121
Spearman, C., 176, 179
Spencer, C. R., 196 f.
Sprott, W. J. H., 232
Stalnaker, Elizabeth M., 164, 172, 181
Starr, H. E., 249
Stecher, L., 27-29, 46, 128
Steinach, E., 255
Stephens, Willie, 257, 260
Stewart, S. F., 42 f.
Stiles, C. W., 195
Stocks, A. V., 194
Stocks, P., 194
Stoddard, George D., 275
Stone, Calvin P., 143-146
Strong, E. K., 195
Sullivan, L. R., 48, 112

Tarbell, G. G., 52
Taylor, 122
Taylor, G. A., 69, 133
Terman, L. M., 16-19, 66 f., 77, 121, 127, 159, 172, 183, 187, 206, 257-259
Thomas, Dorothy S., 288
Thomas, W. I., 256, 288
Thorndike, E. L., 10 f., 13, 15, 169, 276
Tierney, J. L., 144
Toops, H. A., 276
Tredgold, A. F., 188

Ulvin, Gennette M., 256, 260-265, 267

Van Alstyne, D., 133
Venn, J., 84
Viola, 161, 221, 232, 242
Viteles, M. S., 143

Waite, J. H., 195
Walker, 232
Wallin, J. E. W., 200 f.
Wertheimer, F. I., 231 f., 242-245, 270
West, G. M., 37, 39
Westenberger, E. J., 180 f.
Wheeler, L. R., 64-66
Whipple, G. M., 13, 62, 102
Wissler, Clark, 70
Woodrow, H., 13, 127, 129-131, 148
Woodruff, C. S., 25
Woods, F. H., 4
Wylie, A. R. T., 52 f., 104

Index of Subjects

Abnormal personalities, relation to normal personalities, 237

Achievement tests (Educational). *See* School examinations

Acromegaly, *see* Hyper-pituitarism

Adenoids, relation of, to intelligence, 171, 178, 182-187

Adler, Alfred, concept of "organ inferiority," 227 f. *See also* Inferiority attitude

Adolescents, relation between intelligence and physical traits in, 70 f, 137, 138-147, 164 f.

Adults, relation between intelligence and physical traits in, 69-71, 84 f., 89 f., 94-96, 98-115, 120 f., 163-168, 197-199; relation between personality traits and physical traits in, 214-227, 236 f., 242-248; biochemical studies of personality in, 250-254; masculinity ratings of, 260 f.; shoulder-hip ratio in, 263 f.; relation between shoulder-hip ratio and masculinity ratings in, 265 f.

Age-grade location, validity of, as criterion of intelligence, 15, 30 f., 139; relation to: height and weight, 31 f., 34, 41-43, 45; head size, 85 f.

Aggressiveness, relation to physical traits, 226 f.; relation to biochemical reactions, 250-254

American Council on Education, 1924 Psychological Examination for College Freshmen, 166

Anatomical age, ossification of wrist bones as index of, 5, 126 f., 132 (footnote); concept of, 124 f.; relation to: intelligence, 5, 126-138; dentition, 130; pubescence, 130. *See also* Ossification of bone, Ossification ratio

Anthropometric measures of masculinity, description of, 262 f.; reliability of, 262. *See also* Masculinity

Army Alpha Psychological Examination, 163, 245; effect of typhoid inoculation on performance in, 204 f.

Asthenic body type, description of, 232-235; relation to: psychotic temperaments, 236 f., 244; intelligence, 245. *See also* Body build

Athletic body type, description of, 232-235; relation to: psychotic temperaments, 236 f., 244; intelligence, 245. *See also* Body build

Average height in children, definition of, 62 f.

Averages, differences between, deceptive nature of, 31, 33-34. *See also* Method of group comparison

Baldwin-Wood Tables of Height and Weight, 66, 165

Bardeen's ratio, 168

Binet method of interpreting head size measurements, description of, 91; criticism of, 92; use of, in studying relation of head size to intelligence, 92 f.

Biochemical studies of personality traits, 250-254

Biochemistry, use of, in studying personality traits, 248-254

Birth injuries, *see* Central nervous system

Bi-serial *r*, 180, 287

Blind children, head size of, 91 f. *See also* Vision, defective

Blonds, personality traits of, 214-218
Boas standards for height, 54
Body build, theories of, in relation to intelligence and temperament, 5, 220 f.; indices of, 14; kinds of, 161, 231-235; continuity of variation in, 243; relation to: intelligence, 161-169; inferiority attitude, 227-231; psychotic temperament, 236 f. *See also* Morphological index, Height-weight ratio
Bowditch standards for weight, 54
Brachycephaly, description of, 118; and race, 121 f. *See also* Head shape
Brain, *see* Central nervous system
Brain capacity, *see* Head size
Brunettes, personality traits of, 214-218
Burt's revision of the Binet tests, 208-210

Carpal age or development, *see* Ossification ratio
Central nervous system, safeguards of, 175 f., 211 f., 278; effect on intelligence of injuries to, and diseases of, 207-211, 269 f.; need of research on mental effect of injuries to and diseases of, 282
"Central tendency of judgment," description of, 15 f., effect of, on teachers' estimates of intelligence, 36
Cephalic index, relation to intelligence, 99, 116-118, 278; description and divisions of, 118. *See also* Head shape
Cephalometry, *see* crainometry
Cephalic retardation, intellectual significance of, 93 f.
Cervical glands, relation of, to intelligence, 171
Characterology, physical basis of, 213 f.; need of coöperative research on, 268
Chemical psychology, 248-250
Chest girth, relation to Binet M.A., mental maturity, social maturity, educational maturity and achievement, emotional maturity and physical vigor, 134-136
Children, relation between intelligence and physical traits in, 30-69, 85-93, 96-99, 102-113, 115 f., 118-121, 127-137, 138-156, 165, 170 f., 173-187, 192-194, 195-197, 199-204, 207-210; biochemical studies of personality in, 250 f., 253
Children of average intelligence, quantitative studies on relation of height and weight to intelligence in, 30-52; dentition in, 153-155; masculinity ratings of, 257-259
Chronological age, relation to mental age, 45-48, 128, 132, 150
College ability tests (Minnesota), 76, 166, 227
Condition of teeth, relation of, to intelligence, 171, 178, 180, 199-204
Constancy of rate of physical growth, 27
Contingency coefficient, 110 f., 287
Continuity of variation, 12 f., 228, 243
Coöperative research, need of: in determining methods of diagnosing physical vigor, 136; in studying mental effects of dental hygiene, 202; in developing scientific characterology, 268; in studying relation between physical and mental traits, 283 f.
Correlation, *see* Method of correlation
Correlation ratio, 51, 98 f., 287
Cranial capacity, *see* Head size
Cranial measurement, *see* Craniometry
Craniometry, general technique of, 13; theoretical basis of, as indirect method of measuring intelligence, 83 f., 104 f., technique in measuring head size, 84, 89, 91, 114; Binet's researches on, 90-94; Porteus' researches on, 102-112

Cretins, 55, 59, 60 (footnote), 66, cause of, 26, 187; intelligence and physical growth of, 26, 187
Crippled children, intelligence of, 210 f.
Criteria of mental ability or intelligence, age-grade location, 15; teachers' estimates, 15 f., 36 f.; Stanford-Binet tests, 16-19; verbal group tests, 19; school examinations, 41
Cycloid temperament, description of, 237 f.; body build in relation to, 238. *See also,* Cyclothymic, manic-depressives
Cyclothymic temperament, description of, 237-239; body build in relation to, 238; and psychomotor performance, 246. *See also* Cycloid, Manic-depressive psychosis

Davenport's index, 168
Deaf children, head size of, 91 f. *See also* Hearing, defective
Dearborn Group Intelligence test, 65, 130 f.
Dementia praecox, *see* Schizophrenia
Dental caries, *see* Condition of teeth
Dental hygiene, effect of, on intelligence, 199-204; need of research on mental effects of, 282. *See also* Condition of teeth
Dentition, eruption of teeth as index of physical development, 5, 147; technique of measuring, 13, 148; relation to: mental age, 129; anatomical age, 130; intelligence, 147-156
Detroit Primary Group Intelligence Test, 131
Dietetics, need of research on mental effects of, scientific, 282
Dolichocephaly, "long headed," 3; relation to intelligence, 117; 121 f.; and theories of racial superiority, 117, 121 f. *See also* Head shape
Dwarfism, results of, 26 f.; intelligence in cases of, 27

Educational significance, of relation between physical and mental traits, 22, 37-39, 79, 105, 127, 157-159; of pubescence, 138; of dentition, 148
Emotional excitability, relation of, to physical traits, 226 f.; relation to biochemical reactions, 250-254
Emotional instability, theories of relation between body build and, 220 f.
Emotional maturity, relation to anatomical and physiological age, 134-136
Encephalitis lethargica, effect of on intelligence, 207-210
Endocrinology, relation to characterology, 239 f.; and biochemistry, 248-250. *See also* Glands of internal secretion
Environment, influence on intelligence, 21 f.; influence on physical growth, 71 f.; as a cause of intelligence-height, weight correlation, 71-74; influence on masculinity, 265 f.; versus heredity in causing individual differences, 288-290. *See also* Heredity, social-economic status
Eruption of teeth, *see* Dentition
Eunuchoids, physical traits of, 256
Experimental control of third variables, need of, 9, 142, 287. *See also* Partial correlation technique

Fallacies, logical: false simplicity, 10; verbalism, 10, 239-241; particular case, 10; antecedent expectation, 179
Feeble-minded, the, traditional and popular views of, physique of, 3 f., 52, 58; relation of height and weight to intelligence among, 52-66; explanation of apparent physical deficiency of, 55-58, 60-62; explanation of deficiency of, in psycho-physical tests, 58; head size of, 81-83, 104; craniometry as diagnostic of, 90-95, 102-112; dentition in, 153-155. *See also* Feeble-mindedness

Feeble-mindedness, malnutrition as a cause of, 176; encephalitis lethargica as a cause of, 207-210; diseases of and injuries to the brain as causes of, 211. *See also* Feeble-minded
Femininity, *see* Masculinity
Fourfold Association Method of Correlation (Q), 180
Freeman-Rugg Group Intelligence test, 178
Further research, on relation between physique and intellect, suggestions for, 280-284

Genius, Galton's observations on physique of, 5, 24 f.
George Washington Social Intelligence test, 225
Gifted children, popular view of, 3; relation between intelligence and physical traits in, 66-69, 90, 121; dentition in, 153-155; masculinity ratings of, 257-259
Glands of internal secretion, influence of, on mental and physical growth, 26 f., 78 f., 167 f., 187-191; on personality traits, 213, 224, 267 f.; on masculinity, 255 f., 266. *See also* Endocrinology
Glandular therapy, effects of, on cases involving glandular dysfunction, 187-191; need for research on mental effects of, 282
Goddard revision of Binet-Simon tests, 195
Goitre, simple, relation to intelligence, 178, 192-194
Good-naturedness, relation to biochemical reactions, 250-254
Grip, Strength of, relation to: Binet M.A., Mental Maturity, Social Maturity, Educational Maturity and achievement, Emotional Maturity, and Physical Vigor, 134-136; pubescence, 139, 142 f.

"Habitus apoplecticus," 231 f.
"Habitus phthisicus," 231 f.
"Halo" effect, description of, 15
Harvard Growth Study, 65, 130 f., 151-156
Head shape, varieties of, 94, 118; of primitive peoples, 121; relation to: intelligence, 116-121, 123
Head size, relation of, to intelligence, 3, 80-116; of apes, primitive man, and civilized man, 80 f., 111; in microcephaly and in hydrocephaly, 81-83; technique of measuring, 84, 89, 91; racial differences in, 88 f.; norms of, for normal and pathological subjects, 95, 102 f.; sex differences in, 109-112
Hearing, defective, relation to intelligence, 180; need of research on relation of, to intelligence, 282
Heidbreder Inferiority Attitude Rating Scale, 227-231
Heidbreder Introversion—Extraversion Scale, 227
Heidbreder Worries Scale, 227
Height, technique of measuring, 13; of men of genius, 5, 24 f.; theories regarding relation of, to intelligence, 24-30; rôle of heredity in controlling, 78 f.; measurements of body types, 233; uniqueness with respect to mechanical ability, I.Q., and physical agility, 277; relation to: intelligence, 30-74, 135, 171; carpal ossification, 128; pubescence, 139, 142 f.; malnutrition, 172; personality traits, 226, 229. *See also*, Physical growth, Physical growth curves, Relation between physical and mental traits
Height of forehead, "high brow," 3; in relation to intelligence of convicts, 7 f
Height-weight ratio, relation to: morphological index, 162, 167; intelligence, 162-166, 168 f.; inferiority attitude, 227-231. *See also* Morphological index
Heredity, rôle of, with respect to intelligence, 21 f.; rôle of, with respect to stature, 78 f.; versus environment in causing indi-

vidual differences, 288-290. *See also* Environment
Hip width, measurements of body type, 233; of eunuchoids, 256; sex differences in, 263 f. *See also* Masculinity, Shoulder-hip ratio
Holley Picture Completion Test, 179
Hookworm, relation of, to intelligence, 195-197
Hydrocephaly, contrasted with microcephaly, 83
Hyper-pituitarism, results of, 27; effect of glandular therapy on I.Q. in cases of, 190 f.
Hyper-thyroidism, results of, 26; relation of, to microsplanchny, 162
Hypo-pituitarism, results of, 26; effect of glandular therapy on I.Q. in the case of, 190 f. *See also* Dwarfism
Hypo-thyroidism, 26. *See also* Cretinism, Myxedema
Hysteria, *see* Psychoneuroses

Idiots, height and weight, curves of, 55; head size of, 81-83; effect of thyroid gland treatment on, 188
Illinois Group Test of Intelligence, 179
Imbeciles, height and weight curves of, 55 f.
Impacted teeth, *see* condition of teeth
Individual differences (physical and mental), range of, 20, 288; causes of, 20-23, 158, 211 f., 288-290; range of, with respect to onset of puberty, 139
Infantile paralysis, effect of, on intelligence, 211
Inferiority attitude, relation to body build, 227-231; reliability of scale used to measure, 228 f.; traits diagnostic of, 228; relation to physical defects, 230
Intelligence tests, verbal group tests, 19; equivalence of, with educational achievement tests, 189; criticism of, 206 f. *See also* Intelligence, criteria of
Intelligence (verbal or abstract), criteria of, 15-19, 41 f., 45; definition of, 19; influence of environment on, 21 f., 288-290; relation of, to: size of head, 3, 84-116, 122 f.; height and weight, 30-71, 135, 171; craniometry, 83 f.; head shape, 118-121, 123; anatomical age, 127-138; pubescence, 138-147; dentition, 147-156; body build, 162-169; physical defects, 171, 176-182; malnutrition, 172-176; school failure, 181; health practices, 173, 174; adenoids and diseased tonsils, 171, 182-187; glandular therapy, 187-191; simple goitre, 192-194; hookworm, 195-197; intestinal toxemia, 197-199; condition of teeth, 199-204; encephalitis lethargica, 207-210; diseases of, and injuries to the central nervous system, 211; biochemical reactions, 251-253
Intestinal Toxemia, relation of: to intelligence, 197-199; to motor control, 198 f.
I.Q., formula for, 16; constancy of, 16-19; criticism of, 206 f., 275; relation to: height and weight, 43-45, 49, 50, 62 f., 65, 68; head size, 112 f., 115 f.; anatomical and physiological age, 129 f.; pubescence, 142 f., 146; dentition, 150, 153; malnutrition, 173, 174 f.; physical defects, 181 f.; adenoids and diseased tonsils, 183-187; glandular therapy, 189-191; hookworm, 196 f.; encephalitis lethargica, 208-210; biochemical reactions, 251, 253; physical agility, 277; mechanical ability, 277

Knowledge of Sports Test, 257-266
Kretschmer's theories on body build and temperament, 232-248
Kuhlmann-Binet Intelligence Test, 129

Leadership, relation to physical traits, 226 f.; relation to biochemical reactions, 250-254

Lee, Alice, formula for measuring head size, 89, 103, 114

Lung capacity, relation to Binet, M.A., Mental maturity, Social maturity, Educational maturity and achievement, Emotional maturity and Physical vigor, 134-136

Macrosplanchny, description of, 161 f.; relation of, to: intelligence, 162; psychoneuroses, 220 f. *See also* Body types

Malnutrition, relation to: intelligence, 6, 172-176; height and weight, 172; effect of, in infancy, on intelligence, 278

Manic-depressive, description of, 235; body build of, 236 f., 242-248. *See also,* Cyclothymic, Cycloid

Masculinity, dependence upon physical traits, 255 f.; psychological measurement of, 257-262; anthropometric measures of, 257, 262-264. *See also* Shoulder-hip ratio

Measurement, importance of accuracy of, 6 f.

Mechanical ability, relation of, to physical traits, 277

Menstruation, *see* Pubescence

Mental age, and grade location, 17; concept of, 124; relation to: height and weight, 45-48, 59-62; chronological age, 45-48, 128, 132, 150; anatomical age, 127-138; pubescence, 142 f.; body build, 165. *See also* Intelligence

Mental deficiency, *see* Feeblemindedness

Mentally deficient, *see* Feebleminded

Mental growth, as dependent upon physical development, 21; influence of environment on, 21 f.; influence of glands of internal secretion on, 26 f., 78 f.; similarity to physical growth, 27-29; constancy of rate of, 27; effect of encephalitis lethargica on, 207-211. *See also* Mental growth curves

Mental growth curves, 19, 28. *See also* Mental growth

Mesocephaly, description of, 118. *See also* Head shape

Metaphysical notions of relation between physical and mental traits, 25, 241, 272-275

Method of correlation, versus method of group comparison, 31, 33-35, 72 f. (footnote), 85, 129, 224, 284, 287; use of, in studying physical-mental relations, 45-51, 59-61, 67, 69-71, 89 f., 99-101, 107 f., 112-115, 120 f., 128-132, 134-138, 142 f., 149 f., 153, 156, 162-169, 171 f., 180, 194, 197, 219 f., 225-227, 229 f., 252-254, 265 f. *See also* Bi-serial *r*, Contingency coefficient, Correlation ratio, Fourfold Association Method (Q), Multiple correlation, Partial correlation, Tetrachoric correlation

Method of group comparison, versus method of correlation, 31, 33-35, 72 f. (footnote), 77 f., 85, 129, 224, 284, 286 f.; pitfalls in use of, 284-287; use of, in studying physical-mental relations, 41-45, 52-58, 60, 63-68, 84-89, 93, 95-98, 100 f., 115 f., 118-120, 127 f., 140, 148, 151 f., 154 f., 173-187, 193-202, 207-210, 215-219, 222-224

Methodology, relation to conflicting results, 6-9. *See also* Method of correlation, method of group comparison

Microcephaly, and idiocy, 81-83; contrasted with hydrocephaly, 83

Microsplanchny, description of, 161 f.; relation to: intelligence, 162; psychoneuroses, 220 f. *See also* Body types

Mongolians, 55, 59, 60 (footnote), 66

Morons, height and weight curves, 55 f.; head size of, 92

Morphological index, basis for development of, 160-162; and body types, 161 f.; definition of, 161 f., 242; relation to: intelligence, 161-163, 166-168; Height-weight ratio, 162, 167; psychoneuroses, 221 f.; personality traits, 222-227, 242-248. *See also* Height-weight ratio

Multiple correlation technique, use of in studying relation between head size and intelligence, 114 f.

Myxedema, 26

National Intelligence Test, 48

Nervousness, relation to body build, 283

Nervous system, *see* Central nervous system

Neurasthenia, *see* Psychoneuroses

Neuroses, *see* Psychoneuroses

Normal weight child, definition of, 50, 63

Normosplanchny, description of, 161 f.; relation to: intelligence, 162; psychoneuroses, 220 f. *See also* Body types

Nutritional status, technique of measuring, 14; in relation to Binet M.A., mental maturity, social maturity, educational maturity and achievement, emotional maturity and physical vigor, 134-136; relation to intelligence, 171, 172 f. *See also* Malnutrition

"Organ inferiority," *see* Inferiority attitude

Orthopedic cases, *see* Crippled children

Ossification of bones, technique of measuring, 14; use of measurements of, in determining anatomical age, 125 f., 128. *See also* Anatomical age, Ossification Ratio

Ossification ratio, technique of determining, 14; relation to: anatomical age and mental age, 130-132, 134; pubescence and mental age, 142 f. *See also* Anatomical age, Ossification of bones

Otis Advanced Intelligence Test, 192

Otis Group Intelligence Scale, 180, 196 f., 278

Otis Primary test, 48, 131

Over-average height in children, definition of, 62

Overweight child, psychology of, 49 (footnote); definition of, 49 f., 63

Partial correlation technique, use of, 9, 46, 50 f., 59, 128 f., 131-133, 135, 137, 148-150, 165, 171; formula for, 46 (footnote); critical discussion of, 47 f., 287

Pedagogical age, *see* Age-grade location

Percentile method, in physical measurements of the feebleminded, 59 f.; in interpreting head size measurements, 103-109; use of, in interpreting scores on Otis test, 193

Perseverance, relation to physical traits, 226; relation to biochemical reactions, 250-254

Personality traits, definition of, 213; relation to: physiognomy, 214-220; body types, 220-227, 229, 236 f., 242-248; biochemical reactions, 248-254; physical secondary sex traits, 255-266

Phrenology, definition of, 4; results of scientific studies on, 4; doctrine of, with respect to head size, 81-83; studies of validity of, 214-220

Physical constitution, *see* Body build

Physical defects, need for further research on, 282; relation to: intelligence, 5 f., 170-172, 176-182; inferiority attitudes, 227-231

Physical growth, influence of environment on, 21 f.; influence of glands of internal secretion on, 26 f., 78 f.; similarity to mental growth, 27-29; constancy of rate of, 27; specificity of, 78 f., 129 f., 272. *See also* Physical growth curves
Physical growth curves, 29; of bright and dull boys, 40; of feeble-minded, 54-56. *See also* Physical growth
Physical traits, interrelation of, 133-138, 169
Physical vigor, need of improved methods of diagnosis of, 136, 281-282; relation to: anatomical and physiological age, 134-136; intelligence, 173
Physiognomy: definition of, 4; results of scientific studies on, 4; T. L. Kelley's views on, 5 (footnote); F. H. Woods' views on, 4 (footnote); relation to personality traits, 214-220; rules of, 214 f.
Physiological age, relation to intelligence, 45; concept of, 124 f. *See also* Anatomical age, Pubescence
Physiological development, relation to intelligence, 5. *See also* Anatomical age, Pubescence
Pignet's index, 168
Pituitary, *see* Endocrinology, Glands of internal secretion
Poliomyelitis, *see* Infantile paralysis
Porter method of analyzing physical-mental data, 26; description of, 30-33; criticism of, 31, 33-35; further use of, 41-43, 139
Profile, shape of, in relation to personality traits, 218 f.; device for measuring, 219
Propaganda, in behalf of oral hygiene, 199 f.
Psychological measures of masculinity, description of, 257; reliability of, 261 f. *See also* Masculinity
Psychoneuroses, relation of body build to, 220-222
Puberty praecox, description of, 143 f.; relation of, to mental age, 144-147
Pubescence, as index of physical devel., 5; technique of measuring, 13; origin of concept of, 125; importance of, for education, 138; age of onset of, 139; relation to height, weight and strength of grip, 139, 142 f. *See* also Puberty praecox
Pyknic body type, description of, 232-235; relation to: psychotic temperaments, 236 f., 244; intelligence, 245. *See also* Body build

Race, differences in head size, 88 f., 110, 122 f.; and dolichocephaly, 117, 121 f.; and brachycephaly, 121 f.
Rating method, inaccuracy of, in estimating physical traits, 7 f.; validity of, 8; "halo" effect, 15; "central tendency of judgment," 15 f., in obtaining estimates of: intelligence, 89 f., 100 f.; personality traits, 215-220, 227-231, 250-254. *See also* Teachers' estimates
Relation of physical and mental traits, importance for science of genetics, 22, 273 f.; importance for education, 22, 37-39, 79, 105, 127, 157-159; historical reasons for belief in, 24-30, 80-84; importance of studying during childhood, 27, 279-281; in individuals as compared with mankind in the mass, 66, 75-78, 169, 211; influence of glands of internal secretion on, 78 f.; importance for child guidance, 124 f., 138; exaggerated views on, 269 f., 271-273, 275 f.; and theory of unique traits, 276 f.; need of coöperative research on, 283 f.; "nature versus nurture" with respect to, 288-290

Rickets, *see* Malnutrition

Roberts' height and weight table, 53

Sales ability, relation of blondness versus brunetteness to, 218

Schizoid temperament, description of, 237 f.; body build in relation to, 238. *See also* Schizophrenia, Schizothymic

Schizophrenics, description of, 235 f.; body build of, 236 f. *See also* Schizothymic, Schizoid

Schizothymic temperament, description of, 237-239; body build in relation to, 238, 242-248; and psychomotor performance, 246. *See also* Schizophrenia, Schizoid

School examinations (Scholastic standing), as criteria of intelligence, 41 f.; equivalence of, with intelligence tests, 180; relation to: height and weight, 41 f., 69 f.; head size, 84 f., 95 f., 113-115; head shape, 119 f., anatomical and physiological age, 134-136; pubescence, 140; body build, 167; physical defects, 176-180; goitre, 194; inferiority attitude, 227

Selection of subjects, effect of improper, 9; criticism of Porteus' work in regard to, 103 f.; adequate control of, in hookworm studies, 194 f., 197; by method of *systematic* sampling, 285 f.

Sex differences, in cranial capacity, 109-112; in play interests, 257-260; in knowledge of sports, 257, 261; in shoulder-hip ratio, 263 f.; inadequacy of method of group comparison in studying, 286 f.

Sex inversion, concept of, 255 f.

Shoulder-hip ratio, of eunuchoids, 256; sex differences in, 263 f.; relation to psychological measures of masculinity, 265 f. *See also* Masculinity

Shoulder width, measurements of body types, 233; of eunuchoids, 256; sex differences in, 263 f. *See also* Masculinity, Shoulder-hip ratio

Skull capacity, *see* Head size

Sleeping sickness, *see* Encephalitis lethargica

Sociability, relation of, to physical traits, 226 f.

Social-economic status, of feeble-minded and normal children, 57 f.; relation of, to intelligence, 172; need for control of, 285 f.; in relation to inferiority attitudes, 227; effect of, on relation between intelligence and: height or weight, 71-74; head size, 88, 103 f., 278; physical defects, 177, 179; hookworm infection, 197; effect of, on relation between body build and personality traits, 245 f. *See also* Environment

Social intelligence, *see* Personality traits

Social maturity, relation to anatomical and physiological age, 134-136

Spastic paralysis, *see* Central nervous system

Spinal meningitis, effect of, on intelligence, 210

Stamina, *see* Physical vigor

Stammering and biochemistry, 249

Stanford Achievement tests, 180

Stanford-Binet tests, reliability, 16-19; validity, 16-19; use of, in studying physical-mental relations, 45-48, 50 f., 62 f., 66-69, 128, 131, 134 f., 137, 142 f., 149 f., 165, 183-187, 189-191, 207 f.; use of, in studying school failures, 181

Stanford Play Interest Questionnaire, 257-266

Statistical significance of differences between means, use of, 65; interpretation of, 286 f.

Stature, *see* Height

Steinach's gland experiments, 255 (footnote)

Teachers' estimates, as criteria of intelligence, 15 f.; relation to

height and weight, 35-41; relation to head size, 86-89, 96-99; effect of: "central tendency of judgment" on, 36; varying standards of judgment on, 36 f.; coarse grouping on, 36 f. *See also* Rating method
Teeth, *see* Condition of teeth, Dentition
Temperament, *see* Personality traits
Terman Group Test of Mental Ability, 48, 198
Tetrachoric correlation, 287
Thorndike Intelligence Test for High School Seniors and College Freshmen, 70, 120 f., 163, 167 f.
Thyroid gland, *see* Endocrinology, Glandular therapy
Todd formula for cranial capacity, 114
Tonsils, condition of, relation of, to intelligence, 5 f., 171, 178, 180, 182-187
Toxemia, *see* Intestinal toxemia
Tuberculosis of the bones, effect of, on intelligence, 211
Types, physical and mental, 6, 234; errors arising from typology, 9 f.; prevalence of in early psychology, 10; image, 10 f.; Thorndike's single-type theory, 11, 13; multiple type theories, 11, 13; lack of, in introversion-extraversion ratings, 11 f., 228; lack of morphological, 243
Typhoid inoculation, effect of, on intelligence test performance, 204 f.

Ultra-violet ray treatments, need of research on mental effects of, 282
Underweight child, definition of, 50, 63
Under-average height in children, definition of, 62
Unique traits, theory of, 276 f.

Vision, defective, relation to intelligence, 178, 180
Volume of head, *see* Head size

Weight, technique of measuring, 13; theories regarding relation of, to intelligence, 24-30; measurements of body types, 233; relation to: intelligence, 30-74, 135, 171; carpal ossification, 124; pubescence, 139, 142 f.; malnutrition, 172; personality traits, 226, 229, 252 f. *See also*, Physical growth, Physical growth curves, Relation between physical and mental traits
Wood, Thomas D., Height and Weight Table, 134 (footnote)
Woodworth Personal Data Sheet, 222-225, 227

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